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Recreational Fishing

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On the cover:
Clockwise from upper left: Recreational fishing in Alaska (Photo: Richard Yamada), Gulf of Mexico (Photo: Cliff Hutt), California (Photo: James Hilger), and Gulf of Mexico (Photo: Cliff Hutt).

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The Economic Value of Changes in Harvest Regulations to Anglers on Charter and Private Boat Trips: Results from a Choice Experiment Survey in Southeastern U.S. Waters

CHRISTOPHER LIESE and DAVID W. CARTER

Introduction

U.S. law mandates that NOAA's National Marine Fisheries Service (NMFS) consider the anticipated changes in economic value when promulgating new marine fishing regulations. NMFS has used information on anglers' value or willingness to pay (WTP) for catching and keeping fish, derived from stated preference choice experiments (SPCE) or travel cost methods, to measure changes in economic value to the recreational sector.

In this paper, we use a multispecies SPCE with varying levels of bag limits to update estimates of the WTP for marine recreational fishing in the U.S. southeast. Notably, our choice experiment values regulations—not catching or keeping of fish. Others (Carter and Liese, 2012; Lew and Larson, 2014, 2015) use choice experiments that feature regulations. However, these studies also include the expected catch among trip attributes in the SPCE. In our approach, the choice situation faced by respondents in our survey more closely reflects the actual choice situation prior to a fishing trip, where regulations are known but fishing success is not.

Our SPCE modeling also explicitly considers how angler values might vary over the range of potential bag limits, including zero which represents the case when the fishing season is closed. Much of the research on angler preferences assumes that the relationship between angler WTP and catching or keeping fish is linear or other simple function. A constant marginal WTP, i.e., a non-decreasing marginal WTP, is convenient for regulatory analysis, but, if incorrect, could lead to inaccurate estimates of changes in economic value.

Furthermore, anglers' value for regulations and catching or keeping fish might change in discrete ways that are crucial to consider in economic analyses. Anglers might place a large value on the opportunity to keep at least one fish, but value subsequently kept fish relatively less or not at all.

We refer to the case where the angler does not value subsequently kept fish after the first as "open season" preference or specification. For many species, anglers may not expect to catch a large number of fish (if any) so that simply having the option to harvest one fish (per angler on the boat) is the main determinant of value on any given day of fishing.

Another goal of this research is to determine whether anglers' preferences for bag limits depends on how they fish. Specifically, little is known about whether anglers fishing on charter vessels share the same underlying preferences as other recreational anglers. There is considerable research on the preferences of anglers fishing from private boats or from the shore (Johnston et al., 2006). Less research has been conducted on the preferences of anglers fishing from charter boats (Poor and Breece, 2006; Whitehead et al., 2011; Lew and Larson, 2012, 2014, 2015).[1]

Only Lew and Larson (2014) present separate charter and private boat WTP estimates for anglers from the

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[1]Anderson and Lee (2013) and Anderson, Lee, and Levin (2013) include charter and private boat choice experiment questions, but they do not generate separate value estimates for charter and private boat fishing.

ABSTRACT—We estimate the economic value of changes in saltwater fishing regulations to anglers fishing on charter and private boat trips in southeastern U.S. waters. Our new estimates of angler willingness to pay (WTP) are for hypothetical changes in the bag limits for dolphinfish, Coryphaena hippurus*; red snapper,* Lutjanus campechanus*; other/aggregate snappers,* Lutjanidae *spp.; grouper,* Epinephelus *spp. and* Mycteroperca *spp.; and king mackerel,* Scomberomorus cavalla. *We use a multispecies choice experiment with varying levels of regulations (e.g., bag limits), not catching or keeping fish. The focus on changes in regulations, instead of catch, allows us to explicitly consider how angler WTP might vary over the range of potential regulation levels, including closure.*

We compare three specifications of WTP for regulations that span the range of economically reasonable behavior: no decreasing marginal WTP (linear increasing WTP), piece-wise linear WTP, and absolute decreasing marginal WTP, where only the first unit has value (i.e., anglers care about the opening of the season but not about how many fish they may keep). We find absolute decreasing marginal WTP for four out of the five cases we can evaluate. We also test whether the WTP for regulations depends on the mode of fishing (charter or private boat). After controlling for differences in party size, we find no statistical evidence that the WTP differs between the two modes.

same underlying population (residents fishing in southcentral Alaska). They do not formally test whether the comparable WTP estimates for charter boat fishing are different from the WTP estimates for private boat fishing. However, the confidence intervals on the WTP estimates for charter and private boat fishing overlap.

We generate separate estimates of the value of bag limits to anglers fishing on charter boats and private boats and formally compare the estimates. It is important to consider any differences in angler value between charter and private boat fishing modes in economic analyses, especially in cases where different regulations are proposed for each mode.

Beyond the conceptual, a central objective of this paper is to report new estimates of saltwater anglers' WTP for changes in regulations for dolphinfish, *Coryphaena hippurus*; red snapper, *Lutjanus campechanus*; other snappers, *Lutjanidae* spp.; grouper, *Epinephelus* spp. and *Mycteroperca* spp.; and king mackerel, *Scomberomorus cavalla,* on charter and private boat trips in southeastern U.S. waters. We start by examining, for each type of trip (charter or private) and for each species, how the WTP varies over a range of possible bag limit changes. Specifically, we test whether the relationship between WTP and bag limits is linear, non-linear, or discrete, whereby anglers are willing to pay to open the fishery but not for subsequent increases in the bag limit (open season specification). We use a piecewise-linear (PWL) specification for our non-linear modeling of WTP over bag limits because this is the most general specification given the set-up of our SPCE. The PWL specification is commonly used as a general way to model preferences over attributes in choice experiments (Layton and Brown, 2000; Siikamäki and Layton, 2007).

Then, using the best fitting model for each type of trip, we compare the WTP estimates for fishing on charter and private boat trips with each other and estimates from the literature. We conduct the analysis using data from a choice experiment conducted with a mail survey of anglers intercepted on fishing trips in southeastern U.S. waters.

Materials and Methods

Data Collection and Experimental Design

Addresses were collected from willing anglers who were intercepted during or after shore, private boat, or charter boat fishing trips during the 2009 Marine Recreational Information Program (MRIP) access point survey in North Carolina, South Carolina, and Georgia. Any intercepted angler who had taken a charter fishing trip in the previous 12 months and agreed to participate was mailed the South Atlantic Charter Fishing Survey (charter survey). Anglers intercepted on a private boat trip who did not take a charter fishing trip in the previous 12 months, but who agreed to participate, were mailed the South Atlantic Sportfishing Survey (private boat survey). Both surveys consisted of 16 pages of questions about recreational fishing experience and recent activity, preferences for different types of fishing trips, and household characteristics.

The survey instruments were designed with the input of charter captains and recreational anglers. We conducted informal interviews with charter captains at regional marinas before creating the surveys and tested preliminary survey instruments with a series of focus groups. Two focus groups were held with charter captains and two focus groups were held with recreational anglers in locations along the U.S. South Atlantic coast.

There were 15,638 MRIP angler intercept interviews between March and December of 2009 in North Carolina, South Carolina, and Georgia where anglers were asked if they would participate in a follow-up mail survey. Of the 2,277 anglers (15%) who agreed to the follow-up mail survey, 1,537 were sent the charter boat version and 740 were sent the private boat version. There were 805 (52%) charter boat surveys returned and 440 (59%) private boat surveys returned. We oversampled with the charter boat version because of the difficulty of finding anglers with relevant charter boat experience via the MRIP.

Indeed, upon further inspection, only 485 of the 805 returned charter boat surveys included valid responses completed by anglers with some charter boat fishing experience in the southeastern U.S. marine waters (as determined by supporting questions on the survey instrument). By comparison, 373 of the 440 returned private boat surveys had valid responses completed by anglers with private boat experience in the region.

Summary statistics for the anglers who returned usable charter and private boat surveys, respectively, are shown in Table 1. These variables are not used in the model but are presented here as background on the type of anglers included in the surveys. All differences, except age and familiarity with federal regulations, are statistically different based on a t-test.

Anglers who took the charter and private boat surveys are similar in terms of gender, age, and fishing experience. Those who took the charter survey earned slightly more income and were less likely to have a saltwater fishing license. This latter difference is expected, given that a license is not required to fish on a charter vessel, and many of these anglers were intercepted after a charter trip. Similarly, those who took the private-boat survey were recruited after taking a private boat trip, so ownership of both a fishing permit and boat are more likely. In both cases, less than half of the anglers reported being familiar with saltwater fishing regulations in the federal waters of the U.S. southeast.

The charter and private boat surveys each had choice experiment (CE) questions designed to elicit preferences for trip characteristics or attributes (fee, duration, regulations, etc.). Following Oh et al. (2005) and Carter and Liese (2012), the CE questions asked respondents to choose their preferred trip from two hypothetical fishing trips that differ by attribute levels.

Table 1.—Summary statistics for selected variables describing the anglers who were intercepted in 2009 by the Marine Recreational Fishing Statistic Survey in North Carolina, South Carolina, or Georgia, and a) were on any type of fishing trip, had taken a saltwater charter fishing trip in the previous year, and completed the South Atlantic Charter Fishing Survey or b) were on a private boat, did not take a charter fishing trip in the previous year, and completed the South Atlantic Saltwater Sportfishing Survey.

Variable	Responses	Mean	Std. Dev.	Median	Min	Max
Completed the Charter Fishing Survey (n=485)						
Male (%)	481	93%	0.26			
Age	481	50.06	12.88	51	20	73
Income (USD)	461	$109,653	$70,251	$75,000	$12,500	$300,000
Experience (years)	480	27.07	15.85	28	1	65
Boat ownership (%)	485	63%	0.48			
Marine fish license (%)	485	83%	0.38			
Familiar with federal regulations? (%)	485	47%	0.50			
Completed the Sportfishing Survey (n=373)						
Male (%)	373	97%	0.18			
Age	365	49.06	13.85	49	18	73
Income (USD)	352	$96,058	$57,138	$75,000	$12,500	$300,000
Experience (years)	354	29.96	16.12	30	2	65
Boat ownership (%)	373	81%	0.39			
Marine fish license (%)	362	99%	0.07			
Familiar with federal regulations? (%)	357	43%	0.50			

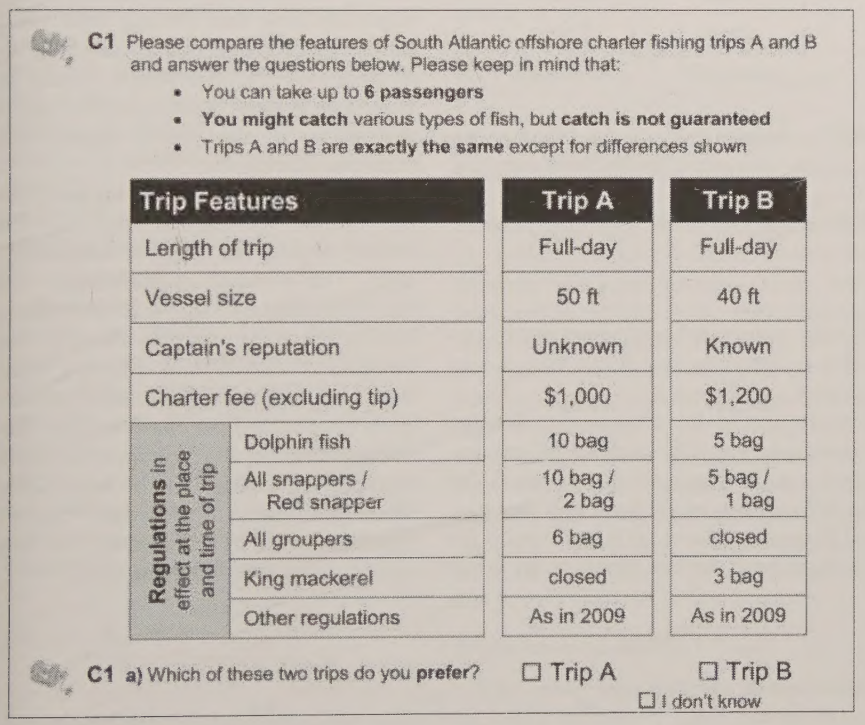

C1 Please compare the features of South Atlantic offshore charter fishing trips A and B and answer the questions below. Please keep in mind that:
• You can take up to 6 passengers
• You might catch various types of fish, but catch is not guaranteed
• Trips A and B are exactly the same except for differences shown
Trip Features
Trip A
Trip B
Length of trip
Full-day
Full-day
Vessel size
50 ft
40 ft
Captain's reputation
Unknown
Known
Charter fee (excluding tip)
$1,000
$1,200
Regulations in effect at the place and time of trip
Dolphin fish
10 bag
5 bag
All snappers / Red snapper
10 bag / 2 bag
5 bag / 1 bag
All groupers
6 bag
closed
King mackerel
closed
3 bag
Other regulations
As in 2009
As in 2009
C1 a) Which of these two trips do you prefer?
☐ Trip A
☐ Trip B
☐ I don't know

Figure 1.—Example choice question from the South Atlantic Charter Fishing Survey.

Each respondent was presented with six CE questions. The first four attributes of the CE questions were customized for the charter and private boat surveys (Fig. 1, 2). The charter survey contained length of trip (half or full day), vessel size (40 or 50 ft.), captain's reputation (unknown or known), and charter fee ($400, $600, $800, $1,000, $1,200, $1,400); whereas the private boat survey contained hours on the water (4 or 8), time of the week (weekday or weekend), bottom type of area fished (artificial or natural), and trip cost ($25, $40, $55, $70, $85, $100).

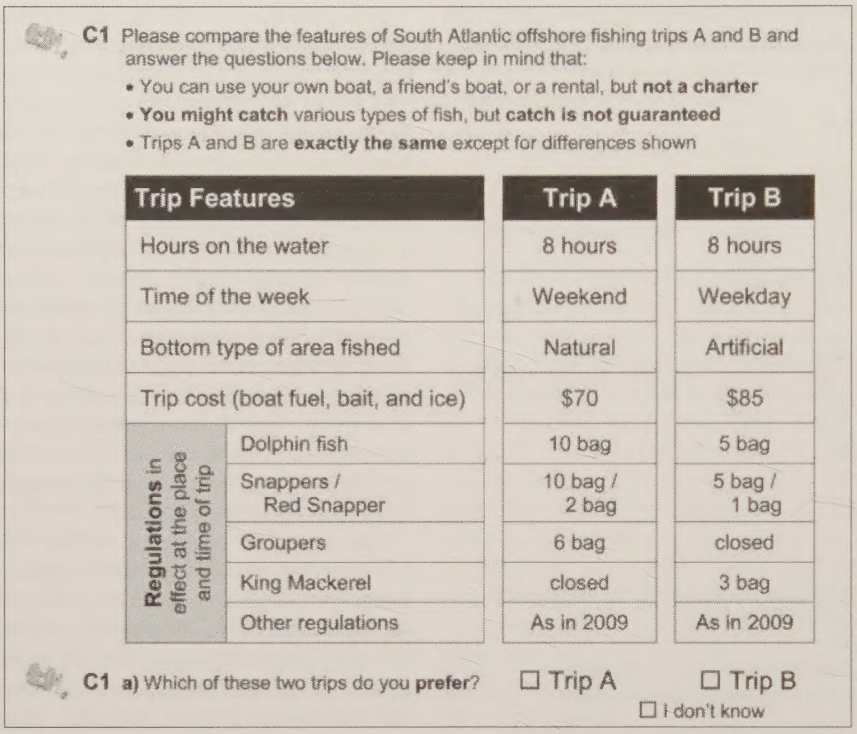
Note that the charter fee and the trip cost attributes were designed to be dependent (nested) on the length of trip and hours on the water, respectively. Specifically, the bottom three dollar levels were linked to the shorter trips, while the top three dollar levels were linked to the longer trips. With regard to captain reputation, the attribute was simply whether the captain's reputation was known or not. This could be a good or bad reputation, but in our focus groups most anglers interpreted whether or not the captain was known to have a "good" reputation. Consequently, we assume that this is how the attribute will be interpreted on average by the survey respondents.

The last five attributes in the CE question represent bag limit regulations for selected species in effect at the time and place of each hypothetical trip. These attributes were the same in the charter and private boat surveys. The following species and bag limit levels were selected: dolphinfish (5 bag or 10 bag), aggregate snapper (5 bag or 10 bag), red snapper (closed, 1 bag, 2 bag, or 3 bag), aggregate grouper (closed, 2 bag, 4 bag, or 6 bag), and king mackerel (closed, 1 bag, 2 bag, or 3 bag).[2]

Another attribute was listed for the level of the other regulations, but this attribute was fixed to read "as in 2009" for all trips. Respondents were asked which of the two trips they preferred. They could select "don't know," but they did not have the option to "not take a trip" because the focus of the analysis is on attribute trade-offs (preferences for trip features), not participation (the decision to take a trip).[3] The experimental design for the CE

[2]The actual daily bag limits in federal waters at the time of the survey were: dolphinfish–10 bag, aggregate snapper–10 bag, red snapper–2 bag, aggregate grouper–3 bag, and king mackerel–2 bag.

[3]Note that the choice questions explicitly asked respondents to only express their preferences among two different trip options (Fig. 1, 2). Even though we did not include the option to not take a trip (opt-out), respondents are not forced to make a choice because they could mark "don't know." Less than 5% of choices in the charter boat survey and fewer than 3% of choices in the private boat survey were marked "don't know" suggesting that respondents were



C1 Please compare the features of South Atlantic offshore fishing trips A and B and answer the questions below. Please keep in mind that:

- You can use your own boat, a friend's boat, or a rental, but **not a charter**
- **You might catch** various types of fish, but **catch is not guaranteed**
- Trips A and B are **exactly the same** except for differences shown

Trip Features		Trip A	Trip B
Hours on the water		8 hours	8 hours
Time of the week		Weekend	Weekday
Bottom type of area fished		Natural	Artificial
Trip cost (boat fuel, bait, and ice)		$70	$85
Regulations in effect at the place and time of trip	Dolphin fish	10 bag	5 bag
	Snappers / Red Snapper	10 bag / 2 bag	5 bag / 1 bag
	Groupers	6 bag	closed
	King Mackerel	closed	3 bag
	Other regulations	As in 2009	As in 2009

C1 a) Which of these two trips do you **prefer**? ☐ Trip A ☐ Trip B ☐ I don't know

Figure 2.—Example choice question from the South Atlantic Sportfishing Survey.

questions is discussed below following the model specification and estimation section.

Model Specification and Estimation

The CE questions involved a choice between Trip A and Trip B as shown in Figure 1 and Figure 2. The choice can be modeled within a random utility framework (McFadden, 1974). Following the framework, we assume that the angler will choose the option that provides the greatest utility. However, we cannot predict with certainty the choice that a given angler will make with the information at hand. There is always some portion of the decision that we cannot observe.

In this case, the best we can do is predict the probability that an angler will choose one of the two options based on the attributes of the trips. Formally, we specify the (indirect) utility associated with charter trip option i, Trip A or Trip B, for angler n on choice question q as

where *fee* is the charter fee for the boat; *party* is the number of passengers on the boat; *fullday* equals 1 for a full day trip and 0 for a half day trip; *ft50* equals 1 for a 50 ft boat and 0 for a 40 ft boat; *known* equals 1 for a trip with a captain of known reputation and 0 for a trip with a captain of unknown reputation; *dolphin10* equals 1 for a 10 dolphinfish bag limit and 0 for a 5 dolphinfish bag limit; *snapper10* equals 1 for a 10 snapper aggregate bag limit and 0 for a 5 snapper aggregate bag limit; *red1*, *red2*, and *red3* equal 1 for a 1, 2, or 3 red snapper bag limit, respectively, and 0 otherwise; *grouper2*, *grouper4*, and *grouper6* equal 1 for a 2, 4, or 6 aggregate grouper bag limit, respectively, and 0 otherwise; *king1*, *king2*, and *king3* equal 1 for a 1, 2, or 3 king mackerel bag limit, respectively, and 0 otherwise; $\alpha 1$ through $\alpha 15$ are the parameters to be estimated and ε^c is an error term representing the unknown factors of the charter trip utility function. Note that the bag limit attributes enter the expression for utility as a piecewise-linear function which is the most general form possible given the set-up of the choice experiment (Layton, 2001).

Also, we assume that, on average, the charter fee for the boat is split evenly among the number of passengers. The number of passengers on each hypothetical trip was not specified in the survey. Eighty-three of the completed charter trip surveys were based on addresses collected from anglers intercepted on charter trips. The average number of passengers on these intercepted charter trips was 4.81. Therefore, we assume that "party" equals 5 for all of the hypothetical trip options specified in equation (1).

$$
\begin{aligned}
U^c_{nqi} &= V^c_{nqi} + \varepsilon^c_{nqi} \\
&= \alpha 1 \cdot \left(\frac{fee_{nqi}}{party_{nqi}} \right) + \alpha 2 \cdot fullday_{nqi} + \alpha 3 \cdot ft50_{nqi} + \alpha 4 \cdot known_{nqi} \\
&+ \alpha 5 \cdot dolphin10_{nqi} + \alpha 6 \cdot snapper10_{nqi} \\
&+ \alpha 7 \cdot red1_{nqi} + \alpha 8 \cdot red2_{nqi} + \alpha 9 \cdot red3_{nqi} \\
&+ \alpha 10 \cdot grouper2_{nqi} + \alpha 11 \cdot grouper4_{nqi} + \alpha 12 \cdot grouper6_{nqi} \\
&+ \alpha 13 \cdot king1_{nqi} + \alpha 14 \cdot king2_{nqi} + \alpha 15 \cdot king3_{nqi} \\
&+ \varepsilon^c_{nqi}
\end{aligned}
\qquad (1)
$$

comfortable declaring their preferences for the trips presented in the CE.

A similar indirect utility function is specified for private boat trip option i, Trip A or Trip B, for angler n on choice question q as

$$
\begin{aligned}
U^{p}_{nqi} &= v^{p}_{nqi} + \varepsilon^{p}_{nqi} \\
&= \beta 1 \cdot cost_{nqi} + \beta 2 \cdot hours8_{nqi} + \beta 3 \cdot weekend_{nqi} + \beta 4 \cdot artificial_{nqi} \\
&+ \beta 5 \cdot dolphin10_{nqi} + \beta 6 \cdot snapper10_{nqi} \\
&+ \beta 7 \cdot red1_{nqi} + \beta 8 \cdot red2_{nqi} + \beta 9 \cdot red3_{nqi} \\
&+ \beta 10 \cdot grouper2_{nqi} + \beta 11 \cdot grouper4_{nqi} + \beta 12 \cdot grouper6_{nqi} \\
&+ \beta 13 \cdot king1_{nqi} + \beta 14 \cdot king2_{nqi} + \beta 15 \cdot king3_{nqi} \\
&+ \varepsilon^{p}_{nqi}
\end{aligned} \tag{2}
$$

where *cost* is the trip cost per angler; *hours8* equals 1 for an 8 hour trip and 0 for a 4 hour trip; *weekend* equals 1 for a trip on the weekend and 0 for a trip during the week; *artificial* equals 1 for a trip fishing over artificial bottom and 0 for a trip fishing over natural bottom; $\beta 1$ through $\beta 15$ are the parameters to be estimated, and ε^{p} is an error term representing the unknown factors of the private boat trip utility function. The bag limit attributes are as defined for equation (1).

Assuming the error terms of the charter and private boat trip utility functions are distributed as independent type-I extreme value random variables, the probability of angler n on choice question q selecting option i (Trip A or Trip B) can be modeled as a conditional logit. For example, the conditional logit probability for the charter trip model is given by

$$
\pi^{c}_{nqi} = \frac{\exp(\lambda^{c} v^{c}_{nqi})}{\sum_{j=1}^{2} \exp(\lambda^{c} v^{c}_{nqj})} \tag{3}
$$

where λ^{c} is a scale parameter.[4] The parameters in (1) along with the parameter covariance matrix are estimated by maximizing the log-likelihood of the probability in (3). Again, continuing with the charter boat trip model example, the log-likelihood is given by

$$
LL(\alpha) = \sum_{n=1}^{485} \sum_{q=1}^{Q_n} \sum_{i=1}^{2} y^{c}_{nqi} Ln\pi^{c}_{nqi} \tag{4}
$$

where y^{c}_{nqi} equals 1 if angler n during choice question q chooses alternative i or 0 otherwise, α is the vector of fifteen parameters to be estimated, and Q_n is the number of choice questions answered by respondent n (Haab and McConnell, 2002). Note that respondents may not have answered all of the choice questions such that $Q_n \leq 6$. Similar expressions for the conditional logit probability, π^{p}_{nqi}, and log-likelihood, $LL(\beta)$, can be defined for the private boat model. The parameters of (1) and (2) are estimated via maximum likelihood using the "mlogit" package of R (R Core Team, 2016; Croissant, 2013).

Experimental Design

The same experimental design was used for the charter and private boat versions of the CE survey questions because the number and levels of the attributes were the same in each version. With one 6-level attribute, four 2-level attributes, and three 4-level attributes, the total possible types of trips based on all permutations of the attribute levels—the full factorial design—consists of $6 \cdot 16 \cdot 64 = 6{,}144$ potential trip types. In principle, over 18.8 million combinations of two trips are possible.

We used SAS software[5] to generate a fractional factorial choice design from these potential trip types (Kuhfeld, 2010). Specifically, a computer algorithm was used to search over the 6,144 potential trip types for 96 pairs of trips (choice sets) that minimized the variance of the logit in (3) conditional on an assumed parameter vector (Ferrini and Scarpa, 2007). However, for the purposes of the experimental choice design algorithm we expanded the angler utility function in equation (1) to include interactions of between trip duration and continuous versions of the non-cost attributes.

The parameters on the first three binary attributes (*fullday*, *50ft*, and *known* in the charter model) were assumed to be 3, 0.5, and 1, respectively, and the parameter on cost was assumed to be -1. All other parameters were fixed at zero in the experimental choice design algorithm. A design with 96 choice sets is too large to show to each angler. Therefore, the design was separated into 16 choice set blocks, and each angler only saw one block of 6 choice sets. Another SAS software algorithm from Kuhfeld (2010) was used to create the blocking factor to be (nearly) uncorrelated with every attribute of both alternatives.

Specification Tests and Model Comparisons

The utility functions for charter and private boat trips shown in (1) and (2) are PWL in the regulations for species with more than 2 levels, i.e., red snapper, grouper, and king mackerel. This is the most general way the regulation variables can enter the utility function. However, angler utility and related WTP might be influenced by regulations in a less complex way.

We consider two additional possibilities. First, the regulations could enter the utility function linearly such that the incremental change from one regulation level to the next is constant or non-decreasing, e.g., the first fish is

[4]More complex assumptions regarding the error terms and different estimators for the final models produced qualitatively similar results to the simple conditional logit specification. The more complex specifications included estimators that allowed the error terms to be correlated across each of the respondent's six choices and estimators that allowed for correlated unobserved factors in the parameters on the regulation attributes (Train, 2009). These results are available upon request.

[5]Mention of trade names of commercial firms does not imply endorsement by the National Marine Fisheries Service, NOAA.

Table 2.—Potential restrictions in the charter boat model.

Species	Linear	Open season
Red snapper	$\alpha 7 = \alpha 8 / 2 = \alpha 9 / 3$	$\alpha 7 = \alpha 8 = \alpha 9$
Grouper	$\alpha 10 / 2 = \alpha 11 / 4 = \alpha 12 / 6$	$\alpha 10 = \alpha 11 = \alpha 12$
King mackerel	$\alpha 13 = \alpha 14 / 2 = \alpha 15 / 3$	$\alpha 13 = \alpha 14 = \alpha 15$

valued the same as the fifth. The linear specification is commonly assumed in sportfishing valuation models. Second, anglers could be willing to pay for an open season, but no additional amount for higher bag limits. These two specifications contain the range of economically reasonable behavior: no decreasing marginal returns to absolute decreasing marginal returns where only the first unit has value.

The parameter restrictions for the charter boat model (1) implied by the linear and open season specifications are summarized in Table 2. The same restrictions apply to the private boat model with β in place of α in the table. We evaluate the plausibility of each restriction for each species by plotting the regulation parameters of the PWL model. Based on the plots we specify a parsimonious model for each trip type that incorporates the plausible set of restrictions suggested by the parameter plots. A likelihood ratio test is used to determine whether the more parsimonious functional relationships between utility and the regulations fits the data at least as well as the PWL specification.

The parameters in (1) and (2) measure the relative angler utility or value associated with each attribute on charter and private boat trips. However, the estimated parameters cannot be directly compared between the charter and private boat models because the models might have different values for the scale parameter (Swait and Louviere, 1993). Dividing each coefficient in each model by the respective coefficient on the trip cost attribute, $\beta 1$ or $\alpha 1$, removes the scale and measures the amount of money that a representative angler would be willing to pay to make him or her indifferent to a one unit increase in an attribute (Bockstael and McConnell, 2007). This measure of angler WTP can be compared between the charter and private boat models.

We calculate the confidence intervals for the parameter ratios for each WTP measure using the approach introduced by Krinsky and Robb (1986) and shown to be an accurate method for WTP measures by Hole (2007). We use 10,000 replications in the Krinsky-Robb method. The simulated WTP vectors based on the 10,000 replications can also be used in the method of convolutions to test the hypothesis that the regulation WTP estimates are the same on charter and private boat trips (Poe et al., 2005). We use the "mded" package in R to perform the hypothesis tests using the method of convolutions (Aizaki, 2015; R Core Team, 2016).

Results

Piecewise-Linear Models and Specification Tests

The maximum likelihood parameter estimates of the PWL conditional logit model parameters are shown in Table 3 for the charter and private boat trip models. The means and confidence intervals for the WTP for each attribute are shown in the last 3 columns of the table. At the maximum, the log likelihood value for the charter boat trip model is -1750.5 which compares with a log likelihood of -1911.4 for a null model that only includes a constant for the Trip B option. A likelihood ratio test ($2 \cdot (1911.4 - 1750.5) = 321.8 \sim \chi^2$, 14 df) rejects the hypothesis that these 2 log likelihoods are equal and indicates that the model as specified fits better than the null model. Similarly, the log likelihood value for the private boat trip model is -1404.3 compared with a log likelihood of -1500.1 for a null model. Again, the likelihood ratio test suggests that the specified private boat model fits better than the null model ($2 \cdot (1500.1 - 1404.3) = 191.6 \sim \chi^2$, 14 df).

As we would expect, anglers are less likely to choose higher cost charter trips, and more likely to choose full-day trips, trips on larger boats, and trips with captains of known reputation. Specifically, full day charter trips are valued at $90 more per person than half-day trips on average, and anglers are willing to pay $72 per person more on average for trips where the captain's reputation is known than for trips where the captain's reputation is unknown.

The size of the charter vessel is less important, but anglers are still willing to pay $11 per person extra on average to fish on a 50-foot vessel instead of a 40-foot vessel. Anglers on private boats are also less likely to choose higher cost private boat trips. However, the other nonregulation private trip attributes are not statistically different from zero even at the 10% significance level.

Higher dolphinfish and aggregate snapper bag limits increase the likelihood of a trip being chosen in both charter and private boat trip models. Anglers are willing to pay $17 and $13 more per person for a 10-fish instead of 5-fish dolphinfish bag limit on charter and private trips, respectively. This amounts to an average of $3.40 per dolphinfish on charter trips and $2.60 per dolphinfish on private boat trips. Similarly, anglers are willing to pay $11 and $8 per person more for a 10-fish instead of 5-fish aggregate snapper bag limit on charter and private trips, respectively. This is an average of $2.20 and $1.60 per snapper on charter and private boat trips, respectively.

We now turn to the results for parameters on the regulations for red snapper, aggregate grouper, and king mackerel which each had four bag limit levels, including zero which would correspond to a closed season. The discussion will make use of Figure 3 and 4 which plot the mean total and incremental WTP for bag limits from the PWL models (charter and private) for each species. We have drawn the

Table 3.—Parameter and willingness-to-pay (WTP) estimates from the piecewise-linear conditional logit trip choice models for charter and private boat trips. The lower bound (LB) and upper bound (UB) of the 95 percent confidence intervals for the WTP estimates are generated using the Krinsky and Robb (1986) method with 10,000 draws.

					WTP (2009 $)		
Attribute	Parameter	Estimate	Std. error	*P*-value	LB	Mean	UB
Charter trips model (485 respondents, 2,758 choices, LL = -1751)							
fee/party	$\alpha 1$	-0.015	0.002	0.000			
fullday	$\alpha 2$	1.309	0.277	0.000	72	90	102
ft50	$\alpha 3$	0.161	0.062	0.009	3	11	17
known	$\alpha 4$	1.039	0.102	0.000	63	72	86
dolphin10	$\alpha 5$	0.244	0.044	0.000	10	17	27
snapper10	$\alpha 6$	0.154	0.043	0.000	5	11	19
red1	$\alpha 7$	0.150	0.071	0.035	1	10	22
red2	$\alpha 8$	0.149	0.071	0.035	1	10	22
red3	$\alpha 9$	0.152	0.062	0.014	2	10	21
grouper2	$\alpha 10$	0.196	0.073	0.007	4	14	26
grouper4	$\alpha 11$	0.348	0.073	0.000	13	24	39
grouper6	$\alpha 12$	0.509	0.062	0.000	24	35	52
king1	$\alpha 13$	0.138	0.075	0.065	0	9	21
king2	$\alpha 14$	0.162	0.071	0.023	1	11	23
king3	$\alpha 15$	0.195	0.061	0.001	5	13	24
Private boat trip model (373 respondents, 2,165 choices, LL = -1404)							
cost	$\beta 1$	-0.019	0.007	0.004			
hours8	$\beta 2$	0.445	0.309	0.150	-26	24	36
weekend	$\beta 3$	-0.101	0.069	0.141	-34	-5	1
artificial	$\beta 4$	-0.002	0.110	0.985	-35	0	7
dolphin10	$\beta 5$	0.242	0.048	0.000	6	13	42
snapper10	$\beta 6$	0.155	0.048	0.001	3	8	28
red1	$\beta 7$	-0.012	0.080	0.880	-13	-1	11
red2	$\beta 8$	0.098	0.080	0.221	-4	5	23
red3	$\beta 9$	-0.085	0.068	0.213	-19	-5	3
grouper2	$\beta 10$	0.546	0.082	0.000	15	29	92
grouper4	$\beta 11$	0.448	0.083	0.000	12	24	79
grouper6	$\beta 12$	0.438	0.070	0.000	12	23	75
king1	$\beta 13$	0.202	0.083	0.015	2	11	37
king2	$\beta 14$	0.226	0.080	0.005	3	12	40
king3	$\beta 15$	0.238	0.068	0.000	5	13	42

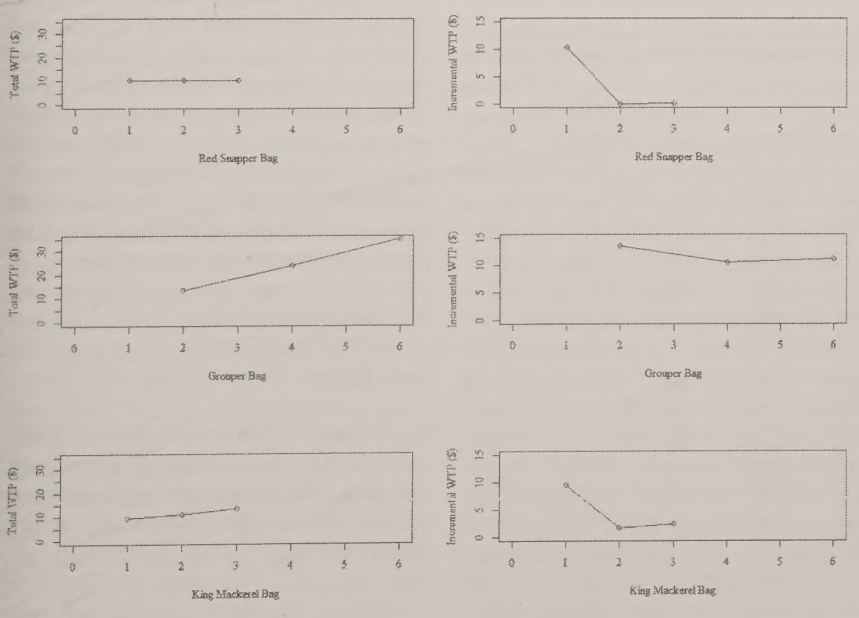


Figure 3.—Total and incremental willingness-to-pay (WTP) for bag limits on charter boat trips.

figures for each species on the same scale for consistency, with the exception of incremental WTP for red snapper and groupers on a private boat trip (which include negative values).

For charter trips, angler utility parameters on all levels of the red snapper bag limits are very similar. Anglers are willing to pay $10 on average to open the red snapper season, i.e., for a 1-fish bag limit, but not willing to pay any additional amounts for further increases in the bag limit. This shape is illustrated in the top two panels of Figure 3 and corresponds to the open season restriction in Table 2 for red snapper. For private boat trips, the parameters for red snapper bag limits are not significantly different from 0, hence these anglers do not assign any value to the option to harvest red snapper. The first row of plots in Figure 4 show the nonsensical shape of the total and incremental WTP for red snapper bag limits on private trips. Rather than drop red snapper bag limits, we proceed with the open season restriction for the specification of the private boat model.

The parameters on the aggregate grouper bag limits and the corresponding WTP estimates for charter trips in Table 3 are statistically significant and very different from each other. However, angler WTP is similar for each 2-fish increment in the grouper bag limit. Anglers are willing to pay $14 on average to open the grouper fishery with a 2-fish bag limit, i.e., to be allowed to keep 2 groupers on charter trips. A third and fourth allowed fish in the aggregate grouper bag are valued together at $10 ($24–$14), and the fifth and sixth fish in the bag are valued at $11 ($35–$24). Again, these incremental values are close, suggesting that the linear model restrictions from Table 2 may be appropriate in this case. The linear relationship between WTP and the grouper bag limit on charter trips is apparent in the second row of plots in Figure 3.

On private boat trips, the parameters and WTP estimates for each level of the grouper bag limit are similar to each other. Specifically, anglers

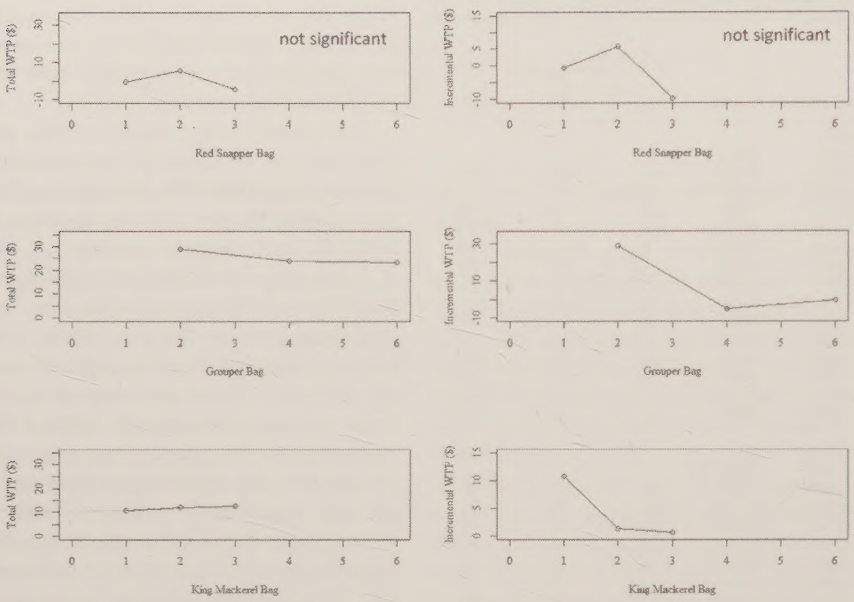


Figure 4.—Total and incremental willingness-to-pay (WTP) for bag limits on private boat trips.

Table 4.—Results from the multinomial logit estimation of the parsimonious trip choice model. The lower bound (LB) and upper bound (UB) of the 95 percent confidence intervals for the WTP estimates are generated using the Krinsky and Robb (1986) method with 10,000 draws.

					WTP (2009 $)		
Attribute	Parameter	Estimate	Std. error	*P*-value	LB	Mean	UB
Charter boat trips (485 respondents, 2,758 choices, LL = -1751)							
fee/party	$\alpha 1'$	-0.014	0.002	0.000			
fullday	$\alpha 2'$	1.302	0.277	0.000	72	90	102
ft50	$\alpha 3'$	0.162	0.062	0.009	3	11	17
known	$\alpha 4'$	1.038	0.101	0.000	63	72	86
dolphin10	$\alpha 5'$	0.246	0.043	0.000	10	17	27
snapper10	$\alpha 6'$	0.156	0.043	0.000	5	11	19
redOpen	$\alpha 7'$	0.153	0.052	0.003	4	11	19
grouperBag	$\alpha 8'$	0.084	0.010	0.000	4	6	9
kingOpen	$\alpha 9'$	0.173	0.052	0.001	5	12	21
Private boat trips (373 respondents, 2,165 choices, LL = -1408)							
cost	$\beta 1'$	-0.019	0.007	0.003			
hours8	$\beta 2'$	0.456	0.308	0.139	-20	24	35
weekend	$\beta 3'$	-0.098	0.068	0.151	-30	-5	1
artificial	$\beta 4'$	0.010	0.110	0.925	-29	1	8
dolphin10	$\beta 5'$	0.244	0.048	0.000	6	13	40
snapper10	$\beta 6'$	0.152	0.048	0.002	3	8	26
redOpen	$\beta 7'$	-0.015	0.058	0.791	-9	-1	7
grouperOpen	$\beta 8'$	0.466	0.061	0.000	14	24	73
kingOpen	$\beta 9'$	0.224	0.058	0.000	5	12	37

on private boat trips are willing to pay $29 on average to open the grouper fishery with a 2-fish bag limit, but are not willing to pay additional amounts for further increases in the bag limit. The plots for grouper in Figure 4 (second row) further suggest that the open-season restrictions from Table 2 are appropriate for the grouper bag limit on private boat trips. Strictly speaking, the values are negative 5 and negative 1 which are not consistent with economic behavior.

Anglers on charter trips are willing to pay $9 per person for a 1-fish bag limit of king mackerel, and $11 and $13, for a bag limit of 2 and 3 king mackerel, respectively. This implies an incremental WTP per person for the first, second, and third fish in the king mackerel bag limit of $10, $2, and $2, respectively. Given the similar magnitude of WTP for the first, second, and third king mackerel bag limits, and the plots in Figure 3 (third row), we assume that the open season restrictions from Table 2 are appropriate for king mackerel on charter boat trips.

The king mackerel bag limit utility parameters appear similar for anglers on private trips and the WTP estimates are very close at $11, $12, and $13 for 1, 2, and 3 fish bag limits, respectively. Based on the similarity of WTP over the range of king mackerel bag limits and the shape of the plots in Figure 4 (third row), we assume that the open season restrictions from Table 2 are appropriate for king mackerel on private boat trips.

Parsimonious Models and WTP on Charter and Private Boats

The regression results for the PWL model and the foregoing discussion suggest the following parsimonious expression for the charter trip utility function:

$$
\begin{aligned}
U^{c'}_{nqi} &= v^{c'}_{nqi} + \varepsilon^{c}_{nqi} \\
&= \alpha 1' \cdot \left(\frac{fee_{nqi}}{party_{nqi}} \right) + \alpha 2' \cdot fullday_{nqi} + \alpha 3' \cdot ft50_{nqi} + \alpha 4' \cdot known_{nqi} \\
&+ \alpha 5' \cdot dolphin10_{nqi} + \alpha 6' \cdot snapper10_{nqi} \\
&+ \alpha 7' \cdot redOpen_{nqi} + \alpha 8' \cdot grouperBag_{nqi} \\
&+ \alpha 9' \cdot kingOpen_{nqi} + \varepsilon^{c}_{nqi}
\end{aligned} \tag{5}
$$

where *redOpen* = (*red1* + *red2* + *red3*), *grouperBag* = (2·*grouper2* + 4·*grouper4* + 6·*grouper6*), and *kingOpen* = (*king1* + *king2* + *king3*). In this model, *redOpen* (*kingOpen*) is 1 when the red snapper (king mackerel) bag limit is 1, 2, or 3 and is 0 for a red snapper (king mackerel) closed season; and the grouper bag limits enter linearly. Similarly, the utility function on private boat trips can be simplified as follows:

$$
\begin{aligned}
U^{p'}_{nqi} &= v^{p'}_{nqi} + \varepsilon^{p}_{nqi} \\
&= \beta 1' \cdot cost_{nqi} + \beta 2' \cdot hours8_{nqi} + \beta 3' \cdot weekend_{nqi} + \beta 4' \cdot artificial_{nqi} \\
&+ \beta 5' \cdot dolphin10_{nqi} + \beta 6' \cdot snapper10_{nqi} \\
&+ \beta 7' \cdot redOpen_{nqi} + \beta 8' \cdot grouperOpen_{nqi} \\
&+ \beta 9' \cdot kingOpen_{nqi} + \varepsilon^{p}_{nqi}
\end{aligned} \tag{6}
$$

where *grouperOpen* = (*grouper2* + *grouper4* + *grouper6*). This specification effectively has 3 binary variables, *redOpen*, *grouperOpen*, and *kingOpen*, for the regulations that equal 1 when fishing for red snapper, grouper, or king mackerel is open and 0 otherwise. Note that we chose to include red snapper in the parsimonious model for private boat trips despite the fact that none of the parameters on the bag limits for this species were statistically significant different from 0 in the PWL model.

The estimated utility parameters and WTP for the parsimonious models are shown in Table 4. Likelihood ratio tests cannot reject the null hypothesis that the parsimonious models fit the same as the PWL models for anglers on charter trips ($2 \cdot (1750.9 - 1750.5) = 0.80 \sim \chi^2$, 6 df) and private boat trips ($2 \cdot (1408.0 - 1404.3) = 7.40 \sim \chi^2$, 6 df). The estimates of WTP for the second through sixth attribute in the parsimonious charter trip model reported in Table 4 are almost identical to the WTP estimates for the same attributes from the PWL charter trip model reported in Table 3. The parsimonious specification (Table 4) for the private trip model also generates WTP estimates that are similar to the PWL specification (Table 3) for the second through sixth attribute.

The results from the parsimonious charter model imply that anglers on charter trips are willing to pay $11 and $12, respectively, to open the red snapper season and king mackerel season regardless of the bag limits available. Anglers on charter trips are also willing to pay $6 for each fish allowed by the grouper bag limit. In this case opening the grouper season is worth $6 with a 1-fish bag, $12 with a 2-fish bag, $18 with a 3-fish bag, and so on.

The results from the parsimonious private boat model suggest that anglers on private boat trips are willing to pay $24 and $12, respectively, to open the grouper and king mackerel seasons regardless of the bag limit available. Anglers on private boat trips in our experiment are not willing to pay anything (different than zero) on average to open the red snapper season with any of the bag limit levels presented in the survey.

The specification of the regulations for dolphinfish, snapper, and king mackerel is the same in the parsimonious charter and private boat models. Therefore, we can test the hypotheses that the WTP for regulations on these species are the same on charter and private boats. Based on the results of the method of convolutions tests, these hypotheses cannot be rejected for any of the species. Specifically, the probabilities (*p*-values) of rejecting the null hypotheses of equality across mode is 0.292, 0.318, and 0.512, respectively, for dolphinfish, snapper, and king mackerel.

Discussion

This paper reported on an analysis of a choice experiment survey of saltwater anglers fishing from North Carolina, South Carolina, and Georgia. We used the survey results to estimate how much anglers fishing on charter and private boats are willing to pay for changes in regulations for dolphinfish, red snapper, other snappers, groupers, and king mackerel. This information is needed to evaluate the economic effects of regulation changes proposed in fishery management plan amendments.

Unlike most previous studies, we value the regulations directly, in our case bag limits, rather than valuing the keeping of fish. This represents a shift in perspective from effectively measuring angler values "after the trip" to "before the trip," when uncertainty about actual catch still prevails.

We find that our approach generates feasible and sensible results. The approach allows for a fully multispecies choice situation, where one species (regulatory) availability is traded-off against that of other species by the respondent. Individual species availability can hence be set to zero (fishing

closed) without making the experiment nonsensical. As a result, we can evaluate the incremental value of bag limits, starting with the first fish. This allows us to compare three specifications of preferences that span the range of economically reasonable behavior: no decreasing marginal WTP (linear increasing WTP), piece-wise linear WTP, and absolute decreasing marginal WTP, where only the first unit (i.e., opening the season) has value.

Qualitatively, for the anglers and species evaluated, we find absolute decreasing marginal WTP for four out of the five cases we can evaluate. For all cases, except grouper by charter anglers, we find that anglers are willing to pay to open the fishery but not willing to pay anything for subsequent increases in the bag limit. At first glance this finding could be interpreted to imply that opening the season with a one fish bag limit for key species will satisfy anglers. However, our results apply to preferences averaged over all types of anglers suggesting that a one fish bag limit might be acceptable on average.

Some groups, particularly expert anglers, will be willing to pay to increase the bag limit beyond one fish. More research is necessary to understand the distribution of angler preferences over the range of regulations considered in our analysis. Such findings could help managers tailor policies to reflect the preferences of specific angler groups (e.g., experts vs. novices) and potentially increase the economic value of the fisheries.

Quantitatively, the estimates of angler WTP for changes in bag limits are similar to the few comparable estimates available in other studies. Comparable estimates are those that focus on the value of changes in saltwater fishing regulations, especially in the U.S. southeast.[6] Recently, Whitehead et al. (2011) estimated that anglers fishing on charter boats in North Carolina in 2007 would be willing to pay $7.72 (in 2009 dollars) on each trip to increase the bag limit for king mackerel by one fish. This is close to our $12 estimate of angler WTP on charter and private boat trips to open the king mackerel season.

Whitehead (2006) estimated that anglers fishing from the shore, private boats, party boats, or charter boats in the southeastern U.S. were willing to pay $3.29 (in 2009 dollars) on average for an annual permit that would increase the king mackerel bag limit by 1 fish on every trip during the year. This is considerably lower than the WTP estimate from our study and the estimate from Whitehead et al. (2011) for king mackerel bag limit change on charter and private boat trips. The estimates are difficult to compare, however, because the Whitehead (2006) estimate is an annual payment for a bag limit change on every trip, whereas our estimate and the Whitehead et al. (2011) estimate refer to the WTP for a bag limit change on one trip.

The Whitehead et al. (2011) charter fishing study also produced a WTP estimate for a one-fish change in the "snapper-grouper" bag limit of $10.30 (in 2009 dollars). This is higher than the average WTP per aggregate snapper of $2.2 ($11/5) going from a 5 fish to a 10 fish bag limit on charter trips in our study. Our estimate of angler WTP of $6 per fish for changes in the grouper bag limit is still lower, but closer to the Whitehead et al. (2011) estimate. Indeed, the Whitehead et al. (2006) estimate of $10.30 per snapper-grouper bag limit unit is just outside our confidence interval of $4 and $9 per grouper bag limit unit. It could be that some snappers are seen as being relatively more valuable than grouper which may have contributed to the relatively higher estimate in the broader category used by Whitehead et al. (2006).

Finally, our study compared anglers' preferences across different modes of fishing: private or charter boat. We find that the amount anglers are willing to pay for changes in dolphinfish, aggregate snapper, and king mackerel regulations does not depend on the mode of fishing. This is not the case, however, for red snapper and grouper.

Anglers on charter boat trips are willing to pay to open the red snapper season, but anglers on private boat trips are not, regardless of the bag limit. That said, in the years studied, red snapper was not often caught by private-boat anglers off the North Carolina through Georgia coast, hence the finding of insignificance might reflect inapplicability of the choice situation, rather than underlying preferences.

In contrast, the WTP of anglers fishing on charter boats increases linearly in the grouper bag limits, whereas anglers fishing on private boats are willing to pay to open the season, but no further amounts for higher bag limits. This does not support the hypothesis that anglers' preferences are the same between the two fishing modes.

We note, though, that for groupers our experiment used increments of two fish. Anglers fishing from private boats are willing to pay nearly twice as much ($24) as those fishing from charter boats ($12) to open the grouper season with a 2-fish bag limit. It may be that anglers fishing from charter boats expect to catch more than two grouper and are, therefore, willing to pay more for each subsequent fish beyond two. Private anglers may not expect to catch more than two fish and so do not show a WTP beyond two fish. More research is needed regarding the implications of angler catch expectations for the value of regulations in different modes of fishing.

Acknowledgments

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[6]This does not include the literature that values changes in harvest rates (Carter and Liese, 2012, provide a recent review), i.e., the literature that values the changes in harvest rates expected to occur with changes in regulations rather than the change in the regulation itself. The value of changes in harvest will typically be higher than the value of changes in regulations on any given trip. The former measures the value of a change in the (average) number of fish taken home, whereas the latter measures the value of a change in the allowable number of fish that can be taken home. For example, an angler may not be willing to pay much for an increase in the bag limit if they do not expect to catch the limit.

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Stated Preferences of Alaska Resident Saltwater Anglers for Contemporary Regulatory Policies

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Introduction

Saltwater recreational fishing in Alaska occurs almost exclusively in two regions: Southeast Alaska and Southcentral Alaska (Fig. 1). The primary saltwater fish targeted by recreational anglers in these regions are Pacific salmon, *Oncorhynchus* spp.; especially Chinook salmon, *O. tshawytscha*, and coho salmon, *O. kisutch*; and the Pacific halibut, *Hippoglossus stenolepis*. Fishery managers rely on bag and size limit restrictions as the principal management tools to manage harvest levels for these species. For state-managed salmon, bag limits and minimum size limits (minimum length of a fish) vary depending upon the time of year and specific location.[1] For federally managed Pacific halibut, bag limits (two fish per day of any size for both unguided and guided/charter boat anglers)[2] were the primary management tool used until 2007.

Since then, management of the Pacific halibut sport fishery in Alaska has undergone a number of significant changes due to concerns over declining stock abundance and distribution, size at age, and allocation disputes between commercial and recreational charter boat fishing interests. Of principal concern are the changes directly affecting anglers[3]—the traditional bag limit regulatory structure for this fishery has been retained, but with a variety of new features such as different size limits for different fish in the bag limit, and "large-or-small fish" size limits that have both a maximum size limit and a higher minimum size limit. These so-called "reverse slot" regulations are designed to protect fish in the intermediate size (and age) range, since they are especially important for reproduction.

To help understand the trade-offs between regulatory tools for managing charter halibut harvest, it is important to understand how angler values are affected. The most common approach used in recent years to evaluate the effect of harvest restrictions on recreational fishing values is the stated preference (SP) method (i.e., Criddle et al., 2003; Carter and Liese, 2012; Anderson and Lee, 2013; Lew and Larson, 2012, 2014, 2015). Stated preference methods use responses to carefully-constructed questions typically asked in a survey to provide information about people's preferences and values (Mitchell and Carson, 1989; Bateman et al., 2002; Kanninen, 2006). The principal reason for the popularity of these methods in fisheries applications is that fishery managers are often interested in the effects of angler harvest regulations under consideration that have yet to be tried, which precludes collection of data on how people respond to the regulations.

One particular type of SP method,

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[1]A detailed discussion of the recent history of Pacific halibut fishery regulation can be found in Lew and Larson (2015) (current regulations can be found at http://www.adfg.alaska.gov/index.cfm?adfg=fishingSportFishingInfo.main).

[2]As used here, guided fishing refers to fishing on for-hire trips.

[3]For a full description of recent changes, see NOAA (2013).

ABSTRACT—Over the last several years, there have been substantial changes to the harvest regulations governing the Pacific halibut, Hippoglossus stenolepis, *fishery off Alaska, notably in the recreational charter boat fishing sector. One change has involved anglers fishing from charter (for hire) boats being subject to increasingly restrictive harvest regulations that do not apply to other anglers. This article analyzes how the economic values that Alaska resident anglers place on charter and private boat fishing is affected by these regulations, which consist of bag and size limits. This information can be helpful to fishery managers in assessing the trade-offs in economic benefits associated with different regulatory tools used to manage angler harvest levels. Using stated preference data from a 2012 survey, we estimate panel rank-ordered mixed logit models to estimate the economic value, or willingness to pay (WTP), Alaska resident anglers place on boat-based saltwater fishing trips in the two principal regions in which saltwater fishing occurs, Southeast Alaska and Southcentral Alaska. The results indicate that Alaska resident anglers have strong preferences for private boat fishing in both regions, with mean values ranging from $172 to over $2,000 per trip, depending upon the species targeted, the regulations, and which region the fishing occurred. Our analysis also suggests that Alaska resident anglers place much less value on charter boat fishing trips for halibut in Southcentral Alaska that are subject to the kinds of restrictive bag and harvest restrictions seen in recent years.*

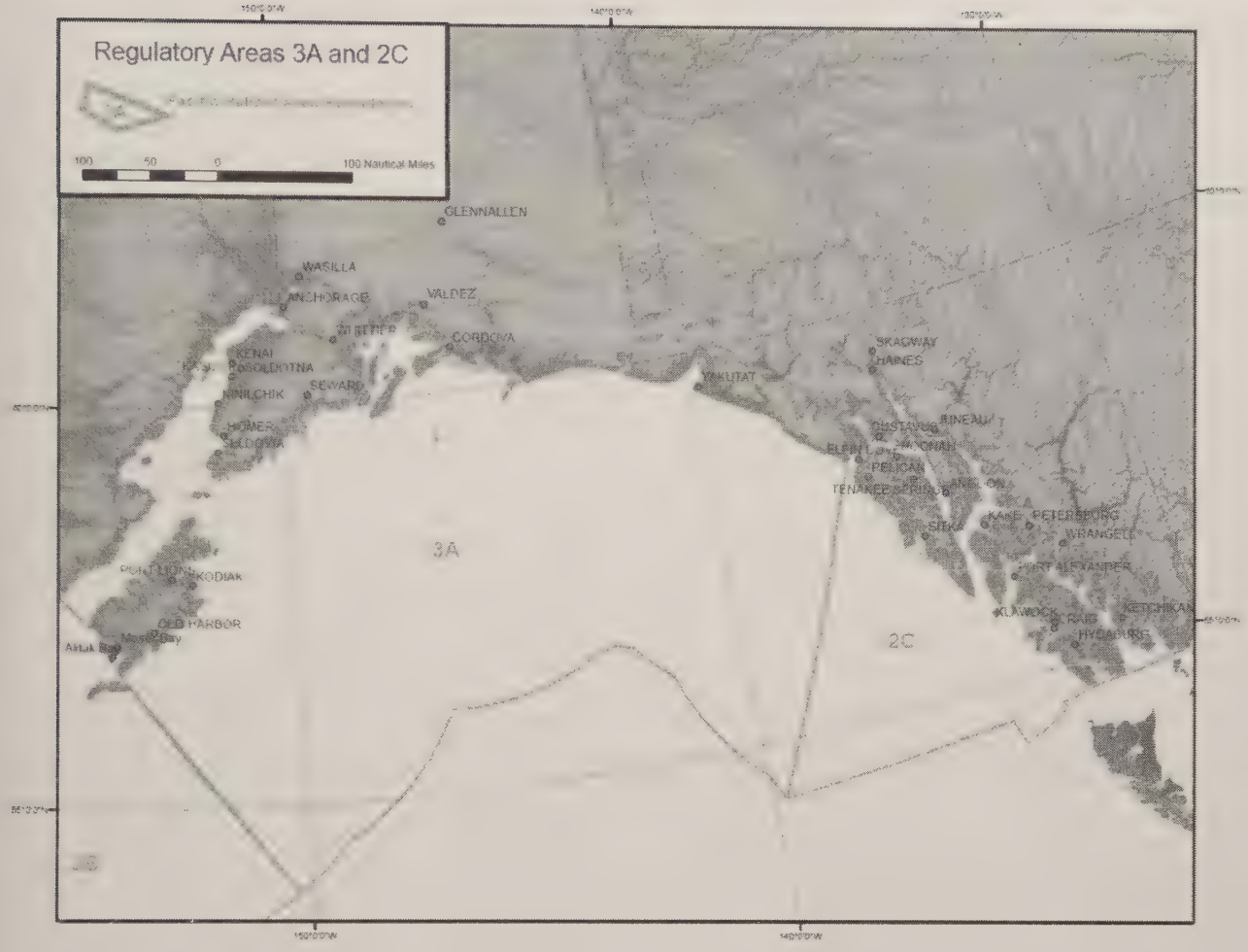
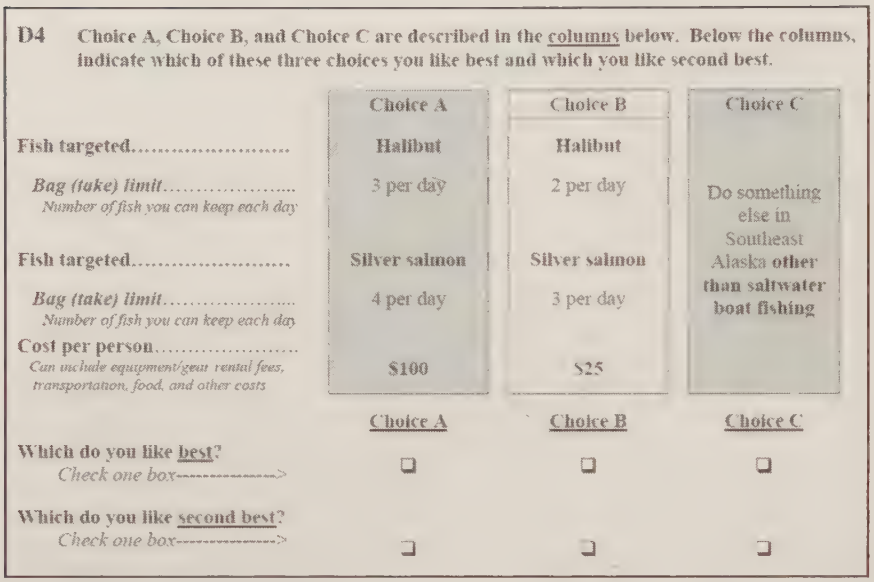


Figure 1.—International Pacific Halibut Commission regulatory areas: Southeast Alaska (2C) and Southcentral Alaska (3A) (source: http://alaskafisheries.noaa.gov/sustainablefisheries/halibut/sport.htm).

the choice experiment (CE), has increasingly been used for valuing the effects of angler harvest regulations because of its ability to provide economic value information across a range of potential policy changes (Kanninen, 2006). Choice experiment questions present a choice between two or more alternatives (e.g., fishing trip options) that are described in terms of several attributes (e.g., trip cost, regulations, fish targeted), one or more of which are policy variables (e.g., bag or size limits). Surveys will generally contain multiple CE questions that differ in the levels of the attributes that make up each option, so a great deal of information about a person's preferences is obtained parsimoniously. Random utility maximization (RUM) models (Louviere et al., 2000) are used with CE responses to predict the probability that a given respondent will choose a particular alternative, and from this both the marginal value of individual attributes and the value of a policy containing several attributes are obtained.

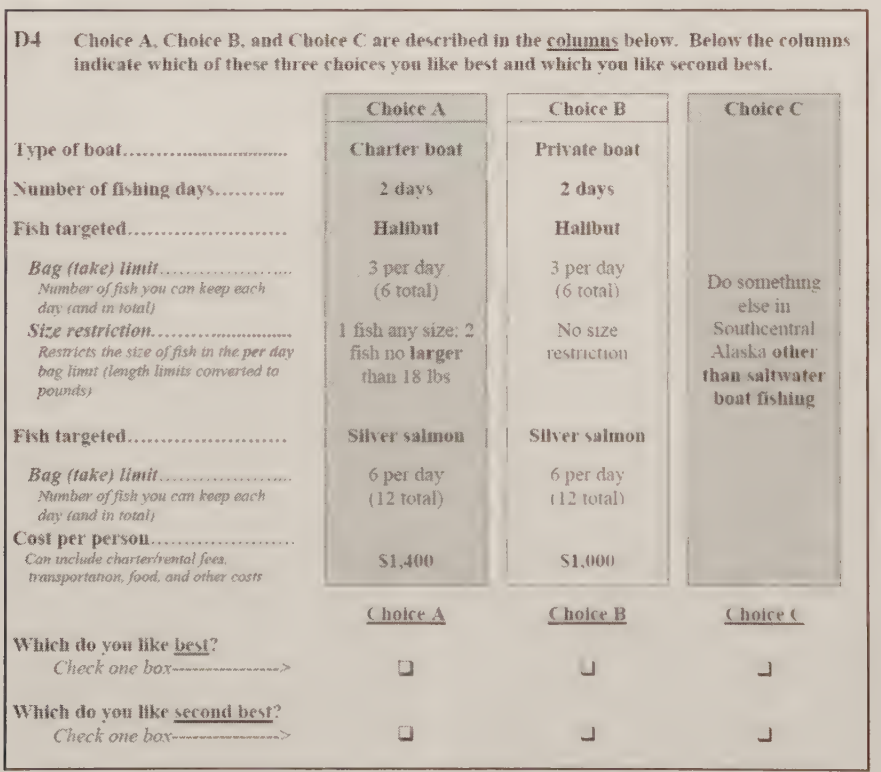
This article investigates how the economic values received by Alaska resident saltwater recreational anglers are affected by different configurations of bag and size limits that are either contemplated for the future or are now in use. The focus on Alaska resident anglers distinguishes this work from Lew and Larson (2015), which focused on nonresident anglers (i.e., anglers who lived outside Alaska). In this study, we use CE data from a 2012 survey of Alaska resident anglers and the methodology of Lew and Larson (2015), who analyzed economic values for halibut and salmon fishing trips associated with Alaska nonresidents, to provide comparable estimates of the values received by residents of both Southcentral and Southeast Alaska. In addition to providing estimates of status quo values, we analyze how these values change with different regulatory configurations. Because they are described well elsewhere in the literature (Lew and Larson, 2015), our dis-



D4 Choice A, Choice B, and Choice C are described in the columns below. Below the columns, indicate which of these three choices you like best and which you like second best.

	Choice A	Choice B	Choice C
Fish targeted	Halibut	Halibut	
Bag (take) limit *Number of fish you can keep each day*	3 per day	2 per day	Do something else in Southeast Alaska other than saltwater boat fishing
Fish targeted	Silver salmon	Silver salmon	
Bag (take) limit *Number of fish you can keep each day*	4 per day	3 per day	
Cost per person *Can include equipment/gear rental fees, transportation, food, and other costs*	$100	$25	
	Choice A	Choice B	Choice C
Which do you like best? *Check one box----------->*	❑	❑	❑
Which do you like second best? *Check one box----------->*	❑	❑	❑

Figure 2.—Example of SE version choice experiment question. Note: The survey uses the common names for Chinook and coho salmon used by anglers in Alaska, king and silver salmon, respectively.



D4 Choice A, Choice B, and Choice C are described in the columns below. Below the columns indicate which of these three choices you like best and which you like second best.

	Choice A	Choice B	Choice C
Type of boat	Charter boat	Private boat	
Number of fishing days	2 days	2 days	
Fish targeted	Halibut	Halibut	
Bag (take) limit *Number of fish you can keep each day (and in total)*	3 per day (6 total)	3 per day (6 total)	Do something else in Southcentral Alaska other than saltwater boat fishing
Size restriction *Restricts the size of fish in the per day bag limit (length limits converted to pounds)*	1 fish any size; 2 fish no larger than 18 lbs	No size restriction	
Fish targeted	Silver salmon	Silver salmon	
Bag (take) limit *Number of fish you can keep each day (and in total)*	6 per day (12 total)	6 per day (12 total)	
Cost per person *Can include charter/rental fees, transportation, food, and other costs*	$1,400	$1,000	
	Choice A	Choice B	Choice C
Which do you like best? *Check one box----------->*	❑	❑	❑
Which do you like second best? *Check one box----------->*	❑	❑	❑

Figure 3.—Example of SC version choice experiment question. Note: The survey uses the common names for Chinook and coho salmon used by anglers in Alaska, king and silver salmon, respectively.

cussions of the data and methods used are somewhat succinct.

Data

Data for this analysis are from a mail survey conducted during the first half of 2012 of Alaska resident anglers who purchased Alaska sport fishing licenses during 2011.[4] The survey was very similar in content to a 2007 survey of Alaska resident anglers (Lew et al., 2010) but was reworked to acknowledge changes in harvest regulations that have occurred in recent years (primarily size restrictions on Pacific halibut for charter boat anglers). It was pretested with Alaska saltwater fishermen via cognitive interviews (Willis, 2005) held in two Alaska cities (Juneau and Anchorage). Fisheries analysts involved in Alaska fishery management also provided valuable input that was incorporated into the survey design.

Surveys contained four CE questions, each of which offered two saltwater boat fishing trips and a third nonsaltwater boat fishing option. Respondents were asked to choose the options they liked best and second best, which allows for a full rank ordering and provides more information than simply modeling which option is preferred. Two separate versions of the survey were developed—the first for resident anglers who live in Southeast Alaska, referred to as the SE version (Fig. 2), and the second for all other resident anglers, referred to as the SC version (Fig. 3). The saltwater boat fishing trips in the CE questions in the SE version were described as occurring in Southeast Alaska. Due to the size of the state, travel for residents between Southeast and Southcentral Alaska is costly, both in terms of time and money. For this reason, few resident anglers of one region have been observed to fish in the other region in previous survey work (Lew et al.,

[4]Sport fishing licenses are required for both nonresidents and Alaska residents aged 16 or older. Residents 60 years or older do not need a sport fishing license to fish in Alaska, but do need to have a "Permanent Identification Card" (PIC). We include PIC holders in the sampling frame used to select the random samples for this study.

Table 1.—Choice experiment attributes and levels.

Attribute	Levels
Type of fishing trip (SC version only)[1]	Private boat or charter
Length of fishing trip (SC version only)[1]	1, 2, or 3 days
Chinook salmon daily bag limit	1, 2, or 3 fish
Coho salmon daily bag limit	3, 4, or 6 fish
Halibut bag daily limit	1, 2, or 3 fish
Maximum size limit on 1st fish in limit	No limit, 18 lb, 23 lb, 28 lb, or 35 lb
Maximum size limit on additional fish in limit beyond 1st fish	No limit, 18 lb, 23 lb, 28 lb, or 35 lb
Minimum size limit (reverse slot)	No min size limit, 130 lb[2]
Daily total fishing trip cost	$25 to $500

[1]There were two versions of the survey: A version developed for Southeast Alaska resident anglers (SE version) and a version for all other Alaska resident anglers (SC version). There were two attributes in the choice experiment questions in the SC version that did not appear in the SE version.
[2] Note that this minimize size limit differs from the realized size limits, which are greater.

Table 2.—Demographic characteristics of the choice experiment samples.

Variable	Description	SE version (Southeast Alaska resident anglers)	SC version (Other Alaska residents)
Gender	% male	65.40%	61.40%
Age	mean in years	47.21	46.09
Fishing experience	mean years	31.46	29.64
Household size	mean number	2.31	2.53
Ethnicity	% Caucasian	88.06%	88.14%
Education	% with college degree or higher	51.0%	55.12%
Household income	mean income	$84,191	$95,858
No. in sample		335	430

2010). Consequently, the CE questions ask about fishing within the resident angler's "home region."

For this same reason, the SC version presented saltwater fishing trip options that would occur in Southcentral Alaska. Attributes in the CE questions in both the SE and SC versions included the species caught—either one or two of the three species available, Pacific halibut, Chinook salmon, and coho salmon; the daily bag (take) limit; size restriction (if any); and the fishing-related costs.

Since saltwater fishing trips in Southeast Alaska typically are day trips only[5], the number of fishing days on the trip was only included as an attribute in the SC version of the survey. Moreover, the SC version includes an attribute that indicates whether the fishing trip was on a private or charter boat. Previous survey results suggested that very few Southeast Alaska residents take charter fishing trips (due in part to residents in this region generally having more access to private fishing boats), so the same attribute was not included in the SE version.

There were 30 versions of the SC survey and 20 versions of the SE survey. These versions differed only in the levels of attributes describing the trips; attribute levels are given in Table 1. The combination of attribute levels seen in each of these survey versions was determined using a procedure that maximized the statistical efficiency of the overall experimental design (Huber and Zwerina, 1996).

The survey implementation followed a modified Dillman Tailored Design Method (Dillman et al., 2014), with an advance letter, survey mailing (which included the survey booklet, cover letter, map, business reply envelope, and a small monetary incentive), thank you/reminder postcard, a second full survey mailing, and a follow-up telephone contact. The overall survey response rates for the SE and SC versions were 46.1% and 41.1%, respectively.[6] Choice experiment data from the two versions were analyzed separately. After removing respondents who did not answer the CE questions consistently or at all, as well as protest responses, the sample sizes used in the analysis were 335 anglers for the SE version analysis and 430 anglers for the SC version analysis.

The demographic group represented most heavily in both samples was older and very experienced Caucasian male anglers (Table 2). The SE and SC samples were generally very similar in terms of demographics with the majority (between 60% and 65% depending on the sample) being male, Caucasian (about 88%), and having a college degree or higher education (between 51% and 55% depending on the sample). Across both samples, the mean age was about 46 or 47 years and mean years of fishing experience was about 30 or 31 years.[7] There were slight differences in household income between the SE and SC samples, with the SE sample having a lower mean income (about $84,000) compared to anglers in the SC sample (about $96,000).

Modeling Approach

To analyze the CE data, we used the panel rank-ordered random utility maximization model described in Lew and Larson (2015), which explicitly accounts for both the rank-order nature of the CE data (Beggs et al., 1981; Chapman and Staelin, 1982) and the panel nature of the data. This approach avoids the restrictive Independence of Irrelevant Alternatives (IIA) assumption embodied in fixed-parameter RUM models by introducing preference heterogeneity, so that some or many parameters are randomly distributed over the population (Train, 2003). To be more precise, in the RUM model the utility (or satisfac-

[5]Based on earlier survey results, about 89% of Southeast Alaska resident angler saltwater fishing trips were single day trips (Lew et al., 2010). Also, we note that although halibut and Chinook and coho salmon are the primary target species on most Alaska saltwater fishing trips, and thus those modeled in the angler's utility specification, other secondary species like other salmon, rockfish, and lingcod may also contribute towards a fishing trip's value.

[6]A total of 1,000 Southeast Alaska anglers and 1,500 other Alaska anglers were randomly selected and contacted to participate (71 and 97 surveys, respectively, from these two sample strata were undeliverable). The sample sizes used in the analysis exclude respondents who did not answer any of the SP questions.

[7]In contrast, about 75% of the nonresident angler sample were male, 95% were Caucasian, mean age was 52.6 years, mean income was a little over $110,000, and mean fishing experience was 35 years. In addition, about two-thirds had at least some college education.

tion) of alternative j (j = A, B, or C) for question i (i = 1,...,4) is assumed to be composed of a systematic component, consisting of observable characteristics or attributes, and a random component:

$$U_{ij} = V_{ij}(\beta) + \varepsilon_{ij}, \qquad (1)$$

where $V_{ij}(\beta)$ is the systematic part of utility and a function of attributes for alternative j in question i, β are parameters of the utility function, and ε_{ij} is an independent and identically distributed Type I extreme value (TEV) error term that represents the part of utility unknown to the researcher. Here it is assumed that the non-cost parameters are randomly distributed over the population; that is, these parameters are assumed to follow a normal distribution. To this end, let $\beta_n \in \beta$ be distributed $\beta_n \sim N(\bar{\beta}_n, \Omega_\beta)$, where $\bar{\beta}_n$ is a vector of mean parameters and Ω_β is a variance-covariance matrix. In practice, this means two parameters for each random parameter are estimated, a mean and standard deviation, which describe the distribution. The individual is assumed to choose the alternative that yields the most utility out of the available choices (A, B, and C) in each question as the "best" choice, and the one with the next largest utility as the "second best" choice. Given the assumption about the distribution of the error term ε_{ij} (and assuming it is independent across the four CE questions in each survey), the probabilities of observing an individual's choice of best (j) and second best (k) for a single choice question take the form:

$$\Pr[j > k > l] = \Pr[j \mid j, k, l] \cdot \Pr[k \mid k, l], \quad (2)$$

where j, k, and l are each one of the elements of the available choices (A, B, and C) and are not equal to one another, $\Pr[j \mid j, k, l] = \int \exp(V_j)/[\exp(V_j) + \exp(V_k) + \exp(V_l)]\, d\beta$ and $\Pr[k \mid k, l] = \int \exp(V_k)/[\exp(V_k) + \exp(V_l)]\, d\beta$ are probabilities evaluated over the distribution of random parameters. This model is estimated by maximum simulated likelihood, where the log-likelihood function is the product of the probabilities in equation 2 over each of the four choice questions. Separate models were estimated for the CE data from the SE sample (SE model) and SC sample (the SC model).

Table 3.—Variable names and definitions.

Name	Description
Nonregulatory attributes	
ASC	Alternative specific constant (dummy variable): 1 = Choice C (nonfishing alternative selected); 0 otherwise
PRIV	Dummy variable for private boat trip (vs. charter trip)
DAY	Days fished (length of trip): 1, 3, or 5 days
COST	Per day cost of fishing trip
Uniform regulatory variables	
HLIM1	Halibut bag limit dummy: 1 = 1 fish; 0 otherwise
HLIM2	Halibut bag limit dummy: 1 = 2 fish; 0 otherwise
HLIM3	Halibut bag limit dummy: 1 = 3 fish; 0 otherwise
KLIM1	Chinook salmon daily bag limit dummy: 1 = 1 fish; 0 otherwise
KLIM2	Chinook salmon daily bag limit dummy: 1 = 2 fish; 0 otherwise
KLIM3	Chinook salmon daily bag limit dummy: 1 = 3 fish; 0 otherwise
SLIM1	Coho salmon daily bag limit dummy: 1 = 3 fish; 0 otherwise
SLIM2	Coho salmon daily bag limit dummy: 1 = 4 fish; 0 otherwise
SLIM3	Coho salmon daily bag limit dummy: 1 = 6 fish; 0 otherwise
HBL	Pacific halibut daily bag limit (if present): 1, 2, or 3 fish; 0 otherwise
HMIN	Halibut minimum size limit in place (dummy variable): 1 = yes; 0 = no
Differentiated regulatory variables	
HMAX1	Halibut maximum size limit on first fish (dummy variable): 1 = yes; 0 otherwise
HMAX2	Halibut maximum size limit on additional fish beyond 1st fish (dummy variable): 1 = yes; 0 otherwise
HALSIZE1	Halibut maximum size limit on first fish (integer): 0, 18, 23, 28, or 35
HALSIZE2	Halibut maximum size limit on add'l. fish beyond 1st (integer): 0, 18, 23, 28, or 35
HNOMAX1	Dummy variable for whether the first fish in halibut bag limit has no size restriction
HNOMAX2	Dummy variable for whether the second fish in halibut bag limit has no size restriction

Model Specification

The systematic component of utility associated with the fishing trip alternatives (Choices A and B in each question) was assumed to be a linear-in-parameters function of two types of variables: non-regulatory and regulatory.

Nonregulatory Variables

For both the SE and SC models, the nonregulatory variables include an alternative-specific constant (ASC) associated with the nonfishing trip option (Choice C) and cost (*COST*). The SC model specification additionally contains a dummy variable for whether the fishing trip is taken with a private boat (PRIV) and the trip length (*DAY*). The first lines of Table 3 contain descriptions of these nonregulatory variables.

Regulatory Variables

Three categories of utility function attributes are needed to describe anglers' preferences for both past and present regulations, as well as potential regulations that have not been implemented, for the salmon and Pacific halibut fisheries. The first two are uniform regulations (a bag limit or size limit applying to the entire day's harvest, which were used historically) and differentiated regulatory variables, which vary for individual fish in the bag limit and have been introduced relatively recently.

To date, regulators have only used uniform regulations for the Alaska salmon fisheries, and there do not appear to be any significant reasons for changing this strategy. In the Pacific halibut fishery, however, managers have been introducing two other categories of regulations: differentiated regulations and compound regulations that either use combinations of size and bag limits, or apply differently for individual fish in the daily harvest, or both.

The salmon fisheries regulations of interest here use just uniform bag limits, which determine the maximum number of fish that can be caught in a day fishing without size limits.[8] As a result, the part of the utility function pertaining to Chinook (king) salmon

[8]There are longstanding size-differentiated regulations for Chinook salmon in both Southeast and Southcentral Alaska, but these are not the subject of this study.

Table 4.—Compound regulatory attributes.[1]

Name	Description	Definition
Reverse slot regulation not in effect		
HBL1FSH	No reverse slot: dummy variable for first fish in halibut bag limit with max size limit (halibut or no halibut): (values = 0, 1)	(HMIN=0)*(HBL>1)*HMAX1
HBL2FSH	No reverse slot: dummy variable for second fish in 2 or 3- bag limit with max size limit (values = 0, 1)	(HMIN=0)*(HBL>1)*HMAX2
HBL3FSH	No reverse slot: dummy variable for third fish in 3-bag limit with max size limit (values = 0, 1)	(HMIN=0)*(HBL>2)*HMAX2
HBL1MAX1	No reverse slot: dummy variable for max size limit in effect on first fish in bag limit when bag limit is 1 fish (values = 0, 1)	(HMIN=0)*(HBL=1)*(HALSIZE1>0)
HBL3MAX1	No reverse slot: dummy variable for max size limit in effect on first fish in bag limit when bag limit is 2 or 3 halibut (values = 0, 1)	(HMIN=0)*(HBL>1)*(HALSIZE1>0)
HBL3MAX2	No reverse slot. dummy variable for max size limit effect on second+ fish in bag limit when bag limit is 2 or 3 halibut (values = 0, 1)	(HMIN=0)*(HBL>1)*(HALSIZE2>0)
Reverse slot regulation in effect		
HML1FSH	Reverse slot: dummy variable for halibut bag limit with max size limit (halibut or no halibut) (values = 0, 1)	(HMIN=1)*(HBL=1)*HMAX1
HML2FSH	Reverse slot: dummy variable for second fish in 2 or 3- bag limit with max size limit (values = 0, 1)	(HMIN=1)*(HBL>1)*HMAX2
HML3FSH	Reverse slot: dummy variable for third fish in 3-bag limit with max size limit (values = 0,1)	(HMIN=1)*(HBL>2)*HMAX2
HML1MAX1	Reverse slot: dummy variable for max size limit in effect on first fish in bag limit when bag limit is 1 fish (values = 0, 1)	(HMIN=1)*(HBL=1)*(HALSIZE1>0)
HML3MAX1	Reverse slot: dummy variable for max size limit in effect on first fish in bag limit when bag limit is 2 or 3 halibut (values = 0, 1)	(HMIN=1)*(HBL>1)*(HALSIZE1>0)
HML3MAX2	Reverse slot: dummy variable max size limit in effect on second+ fish in bag limit when bag limit is 2 or 3 halibut (values = 0, 1)	(HMIN=1)*(HBL>1)*(HALSIZE2>0)

[1]Note: In the SC model, all compound regulatory variables are interacted with the private boat trip dummy variable (PRIV = 0).

includes dummy variables for bag limits of one (KLIM1), two (KLIM2), or three (KLIM3) fish, which cover the range of bag limits actually observed (Table 3). For coho (silver) salmon, dummy variables for bag limits of three (SLIM1), four (SLIM2), and six (SLIM3) fish are used, corresponding to the higher harvest levels permitted in that fishery.

Fishing regulations in the Pacific halibut fishery are more complex. Bag limits have been the primary harvest control tool used in this fishery, but beginning in 2007, compound halibut management regulations were introduced for the charter (guided) fishing sector in Southeast Alaska (International Pacific Halibut Commission [IPHC] regulatory area 2C), in part due to this sector's rapid growth and concomitant increase in harvests. During 2007–08, halibut harvest was managed with a compound regulation consisting of a 2-fish bag limit, with one fish of any size and the other subject to a maximum size limit. In 2009 and 2010, halibut harvest was limited to one fish of any size on charter vessels. In 2011, a compound regulation with a bag limit of one halibut no larger than 37 inches (about 23 lb[9]) was introduced. A further permutation of the compound limit structure was introduced in 2012, with a "reverse slot" regulation that consists of both a maximum size limit and a minimum size limit, with the latter larger than the former.[10]

In 2012–13, the reverse slot regulation in effect was one halibut less than 45 inches (about 43 lb) or greater than 68 inches (about 163 lb). In 2014, this was modified slightly so that the maximum size limit was 44 inches (about 40 lb), with the bag limit and minimum size limit parts of the regulation remaining the same. However, in 2015, the maximum size limit was reduced to 43 inches while the minimum size limit was increased to 80 inches (about 272 lb), which restricted charter anglers in Southeast Alaska to smaller fish or very large fish. Additionally, 2014 marked the first time harvest by charter boat anglers in Southcentral Alaska (IPHC regulatory area 3A) was made subject to a compound regulation, with one of the fish in the two fish bag limit being restricted to 29 inches (about 10 lb) or less. The same regulations were used in Southcentral Alaska during 2015. Given these recent trends in charter halibut regulations, the use of compound regulations, particularly reverse slot regulations, appears likely to continue.[11]

This brief discussion of recent Alaska Pacific halibut regulation makes clear that the interaction of bag limits and two size limits creates many possible regulatory outcomes for Pacific halibut, particularly for the charter fishing sector. The number of fish in a bag limit that are subject to size limit(s), the number that are not, and the levels of the size limits are all potentially important considerations for anglers. In addition, it is important to try to provide information on regulations that may be used in the future. Thus, the utility functions in this study embody considerably more halibut regulation attributes than salmon regulation attributes.[12]

The specific regulatory attributes for Pacific halibut are also listed in Table 3. The additional uniform regulatory variables defined are dummy variables for halibut bag limits of one (HLIM1), two (HLIM2), or three (HLIM3) fish, and an integer variable (HBL, taking values of 0, 1, 2, or 3) representing the number of fish allowed in the bag limit. A final uniform regulation is a dummy variable (HMIN) indicating whether a minimum size limit is in effect; both this and HBL are used in defining compound regulations, which are described in Table 4.

Table 3 also presents several differentiated regulatory variables. They

[9]Standard Pacific halibut length-weight tables available from the IPHC were used to convert minimum size length restrictions into pounds (whole fish), which is the metric most commonly used by Alaska anglers when discussing fish size and the metric used to represent size in the survey discussed in this study. The weight of a fish without its head and entrails is assumed to be 75% of the whole fish weight.

[10]As noted in the introduction, the reverse slot allows the angler to retain either a small or a very large fish, with the goal of the restriction being to protect the breeding stock, which are intermediate in size.

[11]Note that under the Guided Angler Fish provision of the Catch Sharing Plan, which became effective in 2014, charter boat anglers may in some circumstances be able to harvest fish outside of these size limits. For details, see NOAA (2013).

[12]At present, we are not aware of any plans to significantly alter the suite of harvest regulations in the salmon fisheries.

Table 5.—Southeast Alaska (SE) model estimation results (N=335).[1]

Variable	Mean parameter		Standard deviation parameter	
	Estimate	Asymptotic t-value	Estimate	Asymptotic t-value
Nonregulatory attributes				
ASC	**-1.235**	**-3.989**	**4.206**	**12.555**
COST[2]	**-0.013**	**-6.380**		
Uniform regulatory attributes[3]				
HLIM1	**1.466**	**7.843**	**-0.984**	**-2.911**
HLIM2	**2.182**	**10.328**	**-1.879**	**-7.861**
HLIM3	**2.115**	**8.469**	**2.171**	**7.619**
KLIM1	**0.998**	**5.588**	**-0.792**	**-2.498**
KLIM2	**0.976**	**6.138**	**0.653**	**2.267**
KLIM3	**1.035**	**4.533**	-0.204	-0.467
SLIM1	**1.291**	**7.370**	**0.805**	**2.536**
SLIM2	**1.821**	**9.845**	**0.779**	**3.254**
SLIM3	**1.648**	**7.615**	**-1.220**	**-4.319**

[1]Note: Parameters in **bold** are statistically significant at the 5% level.
[2]Trip cost is estimated as a fixed parameter; all others parameters are random.
[3]All trips are unguided (private) boat trips.

include dummy variables indicating whether the first fish in the bag limit (HMAX1) or additional fish in the bag limit (HMAX2) have maximum size limits; and integer variables (HSIZE1 and HSIZE2) indicating what those limits are. In addition, dummy variables define whether the first fish (HNOMAX1) or other fish (HNOMAX2) in the bag limit can be any size or are restricted by a size limit.

Table 4 describes compound regulations that include the reverse slot option and other options that treat individual fish in the bag limit differently. The first set of regulations applies to trips where there is not a reverse slot restriction, but there is a bag limit and a maximum size limit on one or more fish. (These regulations pertain to cases where only a maximum size limit, not a maximum and a minimum, is in effect.) Three dummy variables (HBL1FSH, HBL2FSH, and HBL3FSH) define whether the first, second, or third fish in the bag limit (when applicable) are subject to a maximum size limit. The parameters estimated when these variables are in the model correspondingly measure the marginal utility of the ith fish (i = 1, 2, 3) when it is subject to a maximum size limit.

In addition, since the marginal utility of a size-limited fish may vary depending on the maximum size limit itself, there are three additional dummy variables for the different fish in the bag limit that indicate whether a maximum size limit is applied to that fish. HBL1MAX1 equals one when there is a maximum size limit on the first (only) fish in a 1-fish bag limit, and zero otherwise; similarly, HBL3MAX1 and HBL3MAX2 equal one when there is a maximum size limit on the first and second fish in a multi-fish bag limit, respectively.

Table 4 also contains definitions and descriptions of a set of conditional dummy variables that exactly parallel those just described, but apply to fishing trips where there is a reverse slot option. Thus, HML1FSH, HML2FSH, and HML3FSH are dummy variables for the first, second, and third fish, respectively, with maximum size limits when at least one of them is a part of a reverse slot regulation. HML1MAX1, HML3MAX1, and HML3MAX2 are dummy variables that indicate which fish in the bag limit, if any, has a maximum size limit level imposed on it when there is a one-bag limit (HML1MAX1) or a multi-fish bag limit (HML3MAX1 and HML3MAX2).

Estimation Results

Panel-ordered mixed logit models were estimated using maximum simulated likelihood estimation (Train, 2003; Lew and Larson, 2012) for each sample (SE and SC samples), and the resulting parameter estimates are presented in Table 5 (for Southeast Alaska) and Table 6 (Southcentral Alaska). The estimated models allowed for all noncost parameters to be normally distributed over the population.[13] A

[13]Several alternative model specifications were tried that treated the regulatory variables differently, but they were not qualitatively different from the model presented here. They are available upon request from the authors.

Table 6.—Southcentral Alaska (SC) model estimation results (N=430).[1]

Variable	Mean parameter		Standard deviation parameter	
	Estimate	Asymptotic t-value	Estimate	Asymptotic t-value
Nonregulatory attributes				
ASC	**2.267**	**2.794**	**4.225**	**13.309**
PRIV	**4.041**	**5.919**	**2.547**	**9.0870**
DAY	-0.126	-0.165	**0.799**	**7.213**
DAY squared	-0.155	-0.821	**0.152**	**4.203**
COST[2]	**-0.002**	**-3.618**		
Uniform regulatory attributes				
PB_HLIM1[3]	**1.730**	**4.107**	**-2.878**	**-5.998**
PB_HLIM2	**3.124**	**9.776**	**-0.687**	**-2.032**
PB_HLIM3	**3.044**	**4.649**	**-3.556**	**-4.777**
PB_KLIM1	0.598	1.446	**-2.386**	**-4.951**
PB_KLIM2	0.400	1.122	-0.415	-1.021
PB_KLIM3	*0.755*	*1.894*	**1.391**	**2.665**
PB_SLIM1	**2.122**	**5.254**	*-1.153*	*-1.681*
PB_SLIM2	**1.041**	**2.847**	**1.537**	**4.103**
PB_SLIM3	**1.290**	**3.266**	0.951	1.710
CH_HLIM1	-0.544	0.754	0.4879	0.929
CH_HLIM2	0.722	1.0168	**0.885**	**2.179**
CH_HLIM3	1.493	1.466	0.045	0.061
CH_KLIM1	0.664	1.379	**-2.411**	**-4.618**
CH_KLIM2	**1.586**	**3.827**	-0.367	-0.844
CH_KLIM3	**1.027**	**2.028**	*-0.988*	*-1.779*
CH_SLIM1	**1.708**	**3.144**	**-1.508**	**-3.404**
CH_SLIM2	**0.976**	**2.256**	**-0.935**	**-2.250**
CH_SLIM3	0.598	1.446	**-2.386**	**-4.951**

Continued on next page

[1]Note: Parameters in **bold** are statistically significant at the 5% level. Parameters in *italics* are statistically significant at the 10% level.
[2]Trip cost (number of days times per-day cost) is estimated as a fixed parameter; all others parameters are random.
[3]The prefixes PB_ and CH_ refer to private and charter boat trips, respectively.

Table 6 (continued).—Southcentral Alaska (SC) model estimation results.[1]

Variable	Mean parameter		Standard deviation parameter	
	Estimate	Asymptotic t-value	Estimate	Asymptotic t-value
Differentiated regulatory attributes				
HALSIZE1	0.029	0.820	**-0.086**	**-6.801**
HALSIZE2	**-0.049**	**-2.228**	*0.020*	*1.727*
HNOMAX1	-0.470	-0.510	**-2.136**	**-4.813**
HNOMAX2	-0.619	-0.618	**-0.811**	**-2.017**
Compound regulatory attributes				
HBL1FSH	1.381	1.442	0.355	0.806
HBL1MAX1	-0.736	-0.575	**-2.883**	**-3.533**
HBL2FSH	0.663	0.774	-0.703	-1.425
HBL3FSH	-0.343	-0.350	-0.504	-0.563
HBL3MAX1	-0.073	-0.080	-0.585	-1.143
HBL3MAX2	-0.378	-0.361	**-1.020**	**-2.381**
HML1FSH	**3.888**	**4.121**	**1.813**	**4.910**
HML1MAX1	**-3.0135**	**-2.821**	1.060	1.365
HML2FSH	-0.388	-0.590	0.588	1.436
HML3FSH	0.766	0.770	0.870	1.003
HML3MAX1	0.796	0.751	*0.768*	*1.813*
HML3MAX2	**-3.540**	**-3.207**	**1.178**	**2.679**
Mean log-likelihood	-5.150			
AIC (corrected)	4616.565			
BIC	4895.352			

[1]Note: Parameters in **bold** are statistically significant at the 5% level. Parameters in *italics* are statistically significant at the 10% level. All differentiated and compound regulatory parameters are for charter boat fishing trips only. Standard deviation parameters can be positive or negative, but only the absolute value has meaning in the estimation program and in interpretation of results.

comparison of the mixed logit model results with those from conditional logit models for each specification showed significant improvement in statistical fit by introducing preference heterogeneity by way of random parameters for both the SE and SC models. In fact, as Table 5 presents, 9 of the 10 random parameters in the SE model had statistically significant standard deviation parameters, indicating respondents across the sample varied in terms of how their utility was affected by most of the noncost variables.

The ASC mean parameter was negative and statistically significant, indicating that on average the nonsaltwater boat fishing trip option (Choice C) was not preferred over the saltwater boat fishing trip options, which are assumed for the SE sample to be private boat fishing trips. However, the large and significant standard deviation parameter associated with the ASC suggests there was considerable variation in preferences toward the nonsaltwater boat fishing option across the sample with some preferring it to the fishing options and others preferring the fishing options.

The other mean parameters were generally statistically significant with the expected signs: the cost parameter was negative and highly significant, while all of the regulatory attributes, which are uniform bag limits of different sizes for the three species (Pacific halibut and Chinook and coho salmon) were positive and statistically significant, suggesting there is utility to being allowed to fish (i.e., having a nonzero bag limit). The bag limit mean parameter estimates along with their standard errors (implied by the asymptotic t-statistics) indicate that for halibut and coho salmon, the second fish in the bag limit is valued more highly than the first fish, with no difference in valuation of a 2-fish limit vs. a 3-fish limit for halibut and between a 4-fish and 6-fish limit for coho salmon. Thus, for the average SE resident angler (i.e., evaluating at the mean parameter estimates), there is increasing marginal utility for the first and second fish bag limit but zero marginal utility from relaxing the bag limit to the third level (three fish for halibut and six fish for coho). For Chinook salmon, there is no statistical difference between any of the bag limit mean parameter estimates, implying positive marginal utility of the first fish and zero marginal utility of the second and third fish.

Table 6 presents the results for the SC sample, which contains resident angler respondents who were presented CE questions with both private boat and charter boat fishing trip options. The model results indicate a general preference for the status quo (nonsaltwater boat fishing) option; the mean estimate is significantly positive, and its magnitude relative to the standard deviation estimate suggests that it is positive for the majority of SC anglers. Additionally, they indicate a strong preference for private boat trips relative to charter boat trips, all else being equal: the mean parameter estimate (4.04) relative to the standard deviation estimate (2.55) implies that a large majority of the population of anglers in this region prefers private boat trips. Of the other nonregulatory attributes, trip length (represented by the DAY and DAY squared variables) had a statistically insignificant mean effect, but the significant standard deviations on these variables indicate a considerable dispersion of preferences for trip length in the population. The cost parameter, as expected, was negative and highly significant.

Of the regulatory attributes, the parameter estimates on the uniform bag limits are the most straightforward to interpret in isolation. For private boat trips, bag limits had statistically significant positive mean effects for halibut and coho salmon, but statistically insignificant effects for Chinook salmon, except for the 3-fish bag limit, which is significant and positive (at the 10% level). For halibut, the means of 2- and 3-fish bag limits were both substantially higher than for a single fish bag limit, with no appreciable difference between them. For coho salmon, this was reversed: a 3-fish bag limit had a substantially higher marginal utility than did 4- and 6-fish bag limits, with no appreciable difference between the latter two.

For charter trips, Chinook salmon bag limits (with 2- and 3-fish limits) and coho salmon bag limits (with 3- and 4-fish limits) had statistically significant positive mean effects; the remaining mean effects were insignificant. The significant standard deviation parameters for 2-fish halibut limits, 1-fish Chinook salmon limits, and all of the coho salmon bag limits

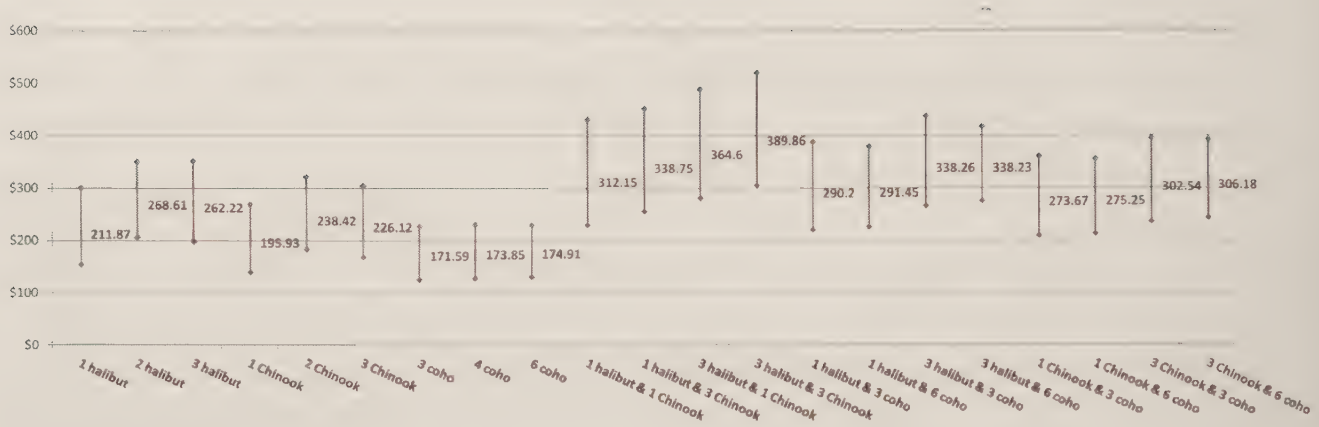


Figure 4.—Total economic values and associated 95% confidence bounds of Southeast Alaska resident anglers for private-boat saltwater trips with different bag limits.

indicate statistically significant dispersion of mean effects.

Each differentiated regulatory attribute had either a significant mean effect or a significant standard deviation. The significant and negative mean and insignificant standard deviation for HALSIZE2, which indicates maximum size limits on all fish in the bag limit beyond the first one, shows a uniform dislike for the regulation. The insignificant mean and significant standard deviation on HALSIZE1 (maximum size limit on the first fish) indicate that some people like, and some dislike, the regulation (independent of HALSIZE2). The same is true for HNOMAX1 and HNOMAX2, which indicate the presence or absence of size limits (whether maximum or minimum) on the first and additional fish, respectively, in the bag limit: some in the population like and some dislike size regulations.

The compound regulations place maximum size limits on one or more fish in the bag limit, with or without minimum size limits. The first set of compound regulation variables (HBL1FSH, HBL2FSH, HBL3FSH, HBL1MAX1, HBL3MAX1, HBL3MAX2), which define maximum size limits only, are generally not statistically significant; only the standard deviation parameters on HBL1MAX1 and HBL3MAX2 are statistically significant, which only indicate utility variation across anglers for maximum size limits. The second set of compound regulation variables (HML1FSH, HML2FSH, HML3FSH, HML1MAX1, HML3MAX1, HML3MAX2) define the reverse slot or combination maximum and minimum size limits, which relative to the first set of variables add the option to catch and retain a very large fish when there is a (maximum) size limit in effect.

The reverse slot option when there is a 1-halibut bag limit (HML1FSH) has a statistically significant positive effect on angler utility. In the presence of the reverse slot option, angler utility decreases with increases in the maximum size limit (lower size limit in the reverse slot restriction) when a 1-fish bag limit is in effect (HML1MAX1) and for all but the first fish when a multiple fish bag limit is in effect (HML3MAX2).

The interactions of these variables cover four of the six cases for regulating individual fish in bag limit limits of up to 3 fish: the only cases not covered are the first fish in a 2- or 3-fish bag limit. These latter two cases are situations where only HML2FSH is in effect, for which there is not a significant effect on utility. For the other cases discussed above, both HML1FSH and HML1MAX1 are in effect, and there is a small (net) positive effect on utility. To summarize these implications, for trips with a reverse slot option to catch a very large fish and a single fish bag limit, there is a positive effect on utility. When the reverse slot option is used on one or more fish with a multi-fish bag limit, the effect on utility is negative, all else being equal.

Economic Values for Fishing

Two types of economic values are calculated using the SE and SC model estimation results: marginal economic values of an attribute associated with a one unit change and the total economic value of, or willingness to pay (WTP) for, a fishing trip with a specific set of attribute levels. The former are important for understanding the incremental effect that trip characteristics, such as the type of boat used and regulations, have on the value of charter fishing trips with all else held constant. In contrast, total economic values of fishing trips represent the WTP for a fishing trip given a specific set of regulations on target species, as they may vary by the type of boat used and area fished.

Figure 4 displays estimates of total value for Southeast Alaska trips with different types of uniform bag limits and 95% confidence bounds for the estimated values (calculated using the Krinsky and Robb, 1986, simulation-based method). These are values associated with 1-day trips on private boats, and all have bag limits of

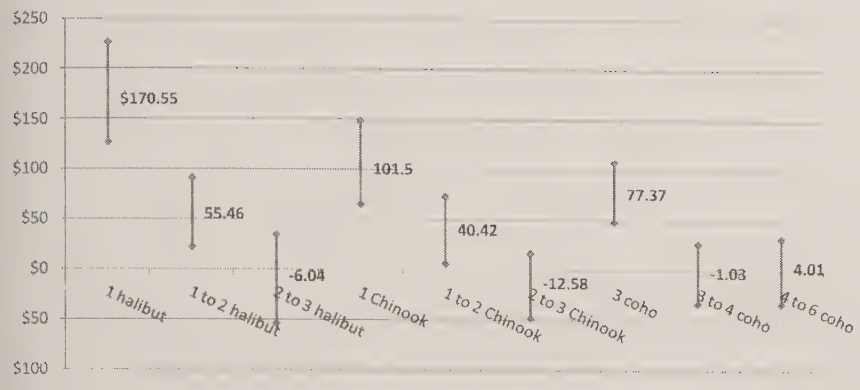


Figure 5.—Marginal values and associated 95% confidence intervals of bag limit changes in Southeast Alaska saltwater fisheries.

different levels. Different values are presented for fishing trips that target different species—some trip values are for single species trips where one species is caught and others are for trips on which more than one species is caught. For single-species bag limit trip values, the mean ranged from about $172 to $269, and all of the lower 5% levels of the confidence intervals are above zero, indicating that total value is strictly positive. Halibut-only and Chinook-only trips with 2- or 3-fish bag limits have higher mean total values than those with 1-fish bag limits, while for coho salmon trips there is no appreciable difference in mean total value regardless of the bag limit (i.e., the confidence intervals are almost identical).

Values associated with trips on which two species are caught are presented for each of the three 2-species combinations ranging from the lowest to highest level of bag limit for each species. Halibut-Chinook trips had mean total values ranging from $312 to $390, while halibut-coho mean trip values ranged from $290 to $338 and Chinook-coho trip values ranged from $273 to $306.

Marginal values of bag limits and associated confidence bounds for each species from the SE model are presented in Figure 5. For each species, the first fish in the bag limit was the most valuable (or, the first three fish for coho salmon), with mean marginal values of 1-fish bag limits being $171 for Pacific halibut, $102 for Chinook salmon, and $77 for coho salmon trips. For both Pacific halibut and Chinook salmon trips, there was a decreasing positive mean marginal utility of the second fish in the bag limit ($55 and $40, respectively), while for coho salmon the mean marginal values of both the increase to 4 fish from 3 fish and to 6 fish from 4 fish in the bag limit were not different from zero statistically.

Total economic values for Southcentral Alaska private boat trips (and the associated confidence bounds) are presented in Figure 6. Private boat trips in Southcentral Alaska were valued more highly than those in Southeast Alaska, with mean total values for halibut-only trips ranging from $1,415 to $2,083 depending on the bag limit, from $831 to $973 for Chinook salmon-only trips, and from $1,119 to $1577 for coho salmon-only trips. As in Southeast Alaska, the lower bounds on the confidence intervals were positive in every case, indicating clearly that the total values are statistically significant and positive. Unlike for the Southeast Alaska trip values, though, there was generally not a clear trend in how total values change with increases in the bag limit; only for an increase from 1 to 2 fish in the Pacific halibut bag limit was there evidence of a (statistically significant) positive change in mean total value (indicated by non-overlapping confidence intervals).

Multiple-species private boat trips in Southcentral Alaska also had mean total values that were considerably higher than those for Southeast Alaska. Not surprisingly, total values for the halibut-coho combination were the highest since these are the highest valued in single-species trips. Adding either halibut or coho to a Chinook salmon trip increases mean total value substantially, while conversely, adding Chinook to either a halibut or coho trip increases mean total value only modestly, by less than one-half of the single-species Chinook mean value.

Strikingly, however, total economic values for charter boat trips in Southcentral Alaska were effectively zero in every case and are therefore not presented. The basic result is that Southcentral Alaska resident anglers on average do not have positive total values for saltwater charter boat fishing trips regardless of the species targeted or regulations. In other words, the mean values for Southcentral Alaska charter boat trips are not statistically different from zero (and in the case of some trips under certain regulations the total trip value was statistically negative). This means the demand for charter boat fishing trips is zero for the average Southcentral Alaska resident angler. This result is not particularly surprising within our model in light of the fact that both the alternative-specific constant (indicating preference for the nonfishing option) and the parameter on the private boat dummy variable were highly significant and positive with large magnitudes. Additionally, the statistical noise around the parameter estimates associated with the charter-specific variables, most of which were not statistically significant, is also likely a major reason for this result. Additional discussion of this is in the next section.

Figure 7 presents the marginal values of trip attributes (and associated confidence intervals) for all Southcentral Alaska saltwater fisheries private boat trips. Reinforcing the point made earlier about private boat trips

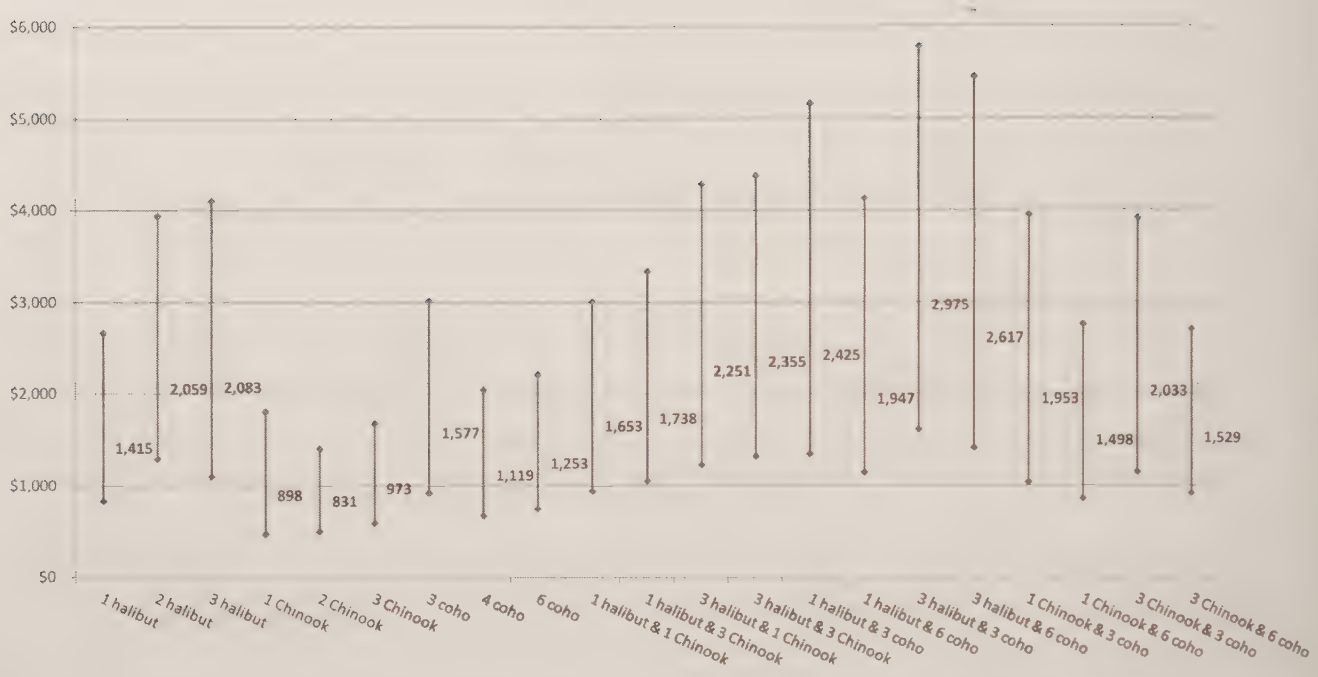


Figure 6.—Total economic values of Southcentral Alaska resident anglers for private-boat saltwater trips with different bag limits.

increasing angler utility, the marginal value of a trip being taken on a private boat, all else equal, is statistically greater than zero with a mean marginal value of about $1,811. For private boat Pacific halibut trips, the mean marginal value of both the increase from 0 to 1 fish and from 1 to 2 fish is positive and significant, while the marginal value of an increase from 2 to 3 fish is not significantly different from zero. For both Chinook and coho salmon trips on private boats, the marginal values of all levels of bag limit increase are not significantly different from zero.

For charter boat Southcentral Alaska trips, most of the marginal values of bag limit increases are not different from zero (Fig. 8). However, for both Pacific halibut and Chinook salmon the marginal value of an increase in bag limit from 1 to 2 fish is significantly positive, as is the increase from 0 to 3 fish in the coho salmon bag limit. However, due to the magnitudes of angler preference for the non-saltwater fishing option, these significant and positive marginal values are not sufficient to shift the total value of saltwater charter fishing trips to be positive.

Discussion

The estimation results and estimated economic values make several points about the Alaska resident saltwater salmon and Pacific halibut fisheries. First, the economic value of the private boat fishery in Southeast Alaska (the predominant way of fishing by residents) is positive and significant, with single-species 1-day trips generating mean total economic values in the range of $172–269, depending on species harvested and the bag limit. Second, the Southcentral Alaska private boat fishery also generates positive and significant total values, and these are considerably larger than in Southeast Alaska: for single-species trips, the mean total value of a 1-day trip ranged from about $831 to $2,083. Third, in both these fisheries, 2-species trips generally are valued more highly than single-species trips, though there is declining marginal value to adding a second species harvest to the trip. Fourth, there is not much evidence that increases in bag limits beyond the first fish for single-species trips increases the total value of a trip. The increase in the Pacific halibut bag limit in Southcentral Alaska from 1 to 2 fish may be the possible exception.

The only charter fishery engaged in by Alaska residents in substantial numbers is the one in Southcentral Alaska. Here, the modeling and economic value estimates indicate strongly that the average total economic value of trips with characteristics similar to those available to anglers in recent years (or any others we tried) is not statistically positive. The estimation results indicate very clearly two facts that explain why. First is a strong preference toward the nonfishing option when compared with charter boat trips, which is indicated by the highly significant, positive, and large coefficient on the alternative-specific constant in the Southcentral Alaska fishery (ASC in Table 6). For the private boat fishery, this is fully offset by the large positive and significant coefficient on the private boat dummy variable (PRIV) in this model.

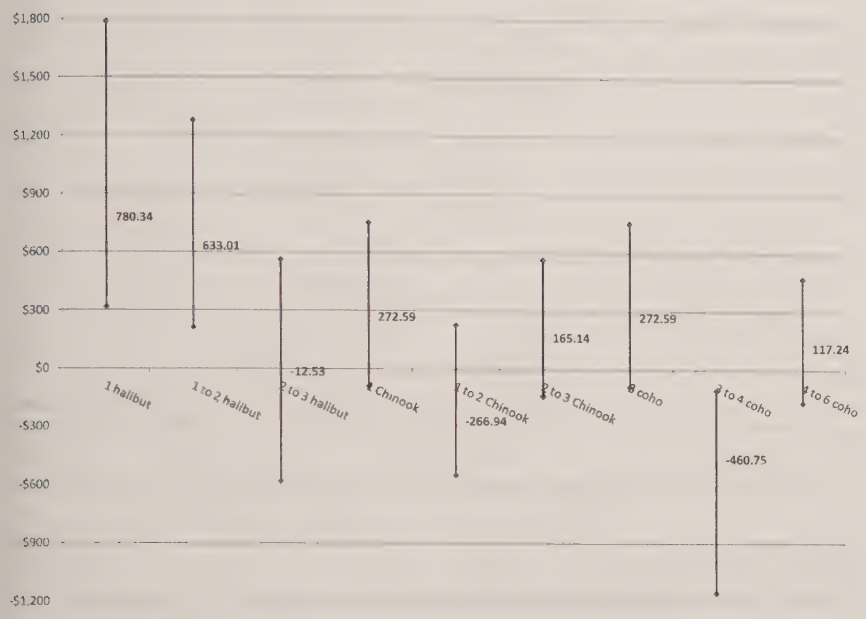


Figure 7.—Marginal values and associated 95% confidence intervals of bag limit changes for private boat saltwater fishing trips by Southcentral Alaska residents.

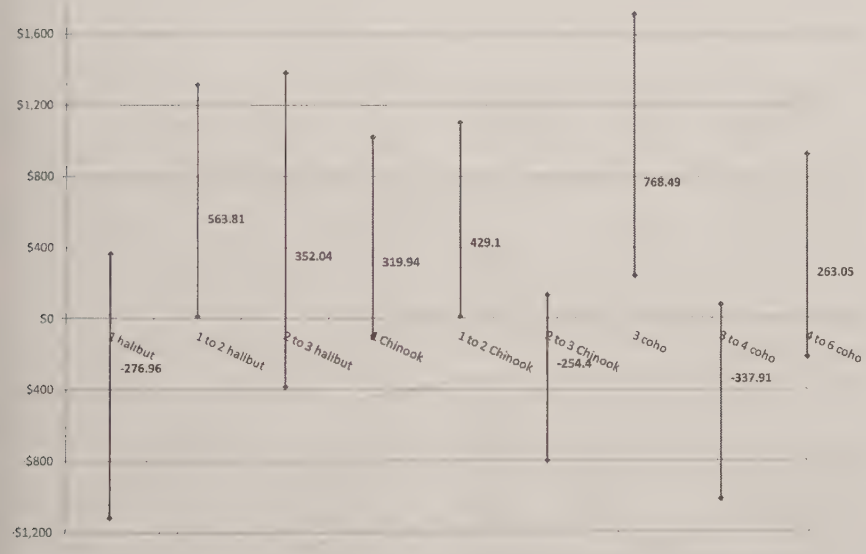


Figure 8.—Marginal values and associated 95% confidence intervals of bag limit changes for charter boat saltwater fishing trips by Southcentral Alaska residents.

This basic conclusion regarding Southcentral Alaska resident anglers' preferences is not changed by including the specific regulations that have been used recently. The reason is that there is virtually no net impact on utility from including most of the differentiated and compound regulations that describe current and recent charter fishing opportunities in the region. The variables for maximum size limits without the reverse slot option all have statistically insignificant mean effects. Three of the variables for maximum size limits with the reverse slot option do have significant mean effects, but their combined effect is near zero for most of the regulatory scenarios possible.

This does not mean that charter boat fishing trips in Southcentral Alaska have no overall total economic value, since the discussion here is just of Alaska residents' preferences. Lew and Larson (2015) found that for nonresidents of Alaska, charter trips with more than a 1-fish bag limit, and those which did not have very small maximum size limits (23 lb in their analysis), had total values of 1-day trips that exceeded $1,150 in every case considered, with several regulatory scenarios generating total values exceeding $2,000. Trips with a 1-fish bag limit and a 23 lb maximum size limit generated total economic values of about $330.

However, each of the Southcentral Alaska charter boat fishing trips with differentiated or compound halibut regulations generated in this study had mean total values to Alaska residents that were not statistically different from zero, while the same trip types generated significantly positive total values to nonresidents of Alaska in the Lew and Larson (2015) study. This suggests that charter boat halibut trips have large total values for the fishery as a whole, but that most of it accrues to nonresidents.

Importantly, at the time of the survey, Southcentral Alaska charter boat trips were not subject to any of the size restrictions asked about in the CE questions. At that time, charter boat anglers in Area 3A were allowed to catch and keep two fish of any size. Thus, in this study SC respondents were asked to choose between fishing trip alternatives that were much stricter in terms of the regulations imposed on charter halibut fishing than they were accustomed to. This likely explains the strong preference for private boat trip alternatives and the nonboat saltwater fishing trip option, which likely greatly contributed to the finding of there being effectively zero demand for saltwater charter fishing trips.

Since this study used data from the same survey effort and a modeling approach similar to Lew and Larson (2015), it is worth briefly mentioning the caveats they discuss that apply here. First, the scenarios we analyze cannot be taken literally as assessments of the economic value of current regulations, since there are some differences between what was anticipated when the study was designed and what regulations were actually implemented. Probably the biggest difference is in the minimum size thresholds for the reverse slot option, which are 130 lb in our scenarios but larger in the actual regulations. This may increase the angler's perception of their chance of being able to keep a large fish, which in turn may increase their valuation of the reverse slot option. This seems unlikely to affect any conclusions in our analysis, since economic values in the halibut charter fishery were statistically zero.

Second, the experimental design was complex to attempt to best reflect the many facets of current halibut regulation. This large design contributed to the wide confidence intervals seen for many regulatory scenarios for halibut. (We have also estimated simpler specifications which aggregate many of the detailed regulatory attributes of this analysis, but the basic conclusions about the effects of regulation and economic values do not change qualitatively.[14]) This was not an issue for the salmon scenarios since they involved bag limits only and therefore required a relatively simple experimental design.

Third, the estimated total economic values are WTP values, not net economic values. Thus, the charter prices, which in recent years have ranged from about $300 for a single day trip to about $1,500 or more for a multi-day trip, and travel costs (e.g., fuel) from the angler's home to the dock need to be accounted for. These costs must be subtracted from the WTP estimates presented in this paper to generate net economic trip values. Fourth, the significance of the standard deviation terms suggests that heterogeneity of preferences across anglers is important, with considerable variation of total values of regulatory scenarios across the sample.

In addition to these caveats that are shared with the nonresident angler analysis in Lew and Larson (2015), we note several additional ones that are important limitations specific to our analysis of Alaska resident anglers. First, compared to the nonresident sample in Lew and Larson (2015) (of 825 respondents), the SC sample had roughly half as many respondents (430 resident anglers). However, the same fairly complex utility specification was applied in both studies. In the present case there were far fewer statistically significant parameters associated with the charter-specific halibut harvest regulations. It is possible this may be a product of the smaller sample being used in a complex model specification and there not being sufficient sample to isolate the effects of the regulatory attributes.[15] Thus, given the complexity of contemporary regulations related to charter fishing in Alaska, future analyses may need to utilize much larger samples.

Second, we note that our Alaska resident samples are not limited to saltwater anglers. Among survey respondents in the SC sample, for example, half had fished in saltwater during the 2011 fishing season, and 21% had fished by charter boat (the remainder of the saltwater anglers had only fished by private boat or from shore). Our results, however, are based on analyzing CE responses from any Alaska resident angler who was licensed to fish in Alaska during 2011, regardless of their experience saltwater fishing.

Although it is likely that preferences for saltwater fishing trips will differ between those who primarily fish in saltwater compared to those who primarily fish in freshwater, we do not distinguish or investigate these differences here since our principal goal was to generate estimates of saltwater fishing opportunities for all anglers, both those who have saltwater fished and those that would potentially do so. However, we acknowledge that future research can and should be done to investigate the differences in values and preferences between these angler types.

Conclusions

This article has presented results on the value of saltwater charter boat fishing trips to Alaska residents using data from a 2012 survey of nonresident anglers in a stated preference choice experiment analysis. The econometric estimation approaches utilized here followed those used in Lew and Larson (2015). Moreover, the results of this study are intended to complement the economic value information from Lew and Larson (2015), which consisted of economic values for saltwater fishing of Alaska nonresidents. Together, the two studies provide a relatively complete picture of saltwater angler preferences in Alaska (circa 2012), and the economic values they generate.

As with the previous study, an important goal is to be responsive to the potential needs of fishery managers for information about economic values when considering modifications to existing regulations. Because the regulatory landscape has been changing rapidly for Pacific halibut, a focus was placed primarily on regulations for that fishery. This is needed since an annual evaluation of recreational harvest regulations is now a formal part of the regulatory process under the newly-implemented halibut catch sharing plan (NOAA, 2013). Since recent regulations for Pacific halibut have been applied specifically to the charter sector in Alaska and are stricter than those applied to unguided anglers,

[14]These results are available on request from the authors.

[15]Technically, to isolate the marginal effects of variables in the RUM model, the attribute levels need to vary considerably across the alternatives seen by respondents, and there needs to be at least some people who choose alternatives that cover the range of attribute levels for the model to fit well. In this application, the smaller sample size (N=435) may not have been sufficient for this purpose.

understanding the role of regulations on the charter sector is especially important.

A second goal of the article is to increase the available knowledge about economic values associated with recreational charter boat fishing for both salmon and Pacific halibut in recent years, since regulations, personal preferences for fishing, and broad economic conditions change, and with them the economic values of fishing can change. Providing economic value information for each of the principal types of fishery users can help fishery managers better understand the effects that changes in regulations have on different groups of people, which often differ.

Our results indicate that the private boat fisheries for both Pacific halibut and salmon have significantly positive total economic values to Alaska residents. These values ranged from about $172 to $2,083 for 1-day trips, depending on the species harvested and the bag limit and which region in Alaska the fishing trip occurred. In contrast, the charter boat fisheries for these species have total trip values that are generally not statistically positive and thus indicate there is no significant demand among residents for the types of restrictive charter boat fishing trips that have been prevalent in recent years. The reasons for this appear to be the strong preferences of Alaska residents for private boat fishing or other options over saltwater charter boat fishing.

As a result, the differentiated and compound regulations that characterize recent Pacific halibut regulations in the charter boat sector had no practical effect on economic values in 2012, since the total values of charter boat trips are effectively zero with or without them. Additional findings are that private boat trips where two species are harvested have higher total value to anglers than single species trips, but it is a proportionately smaller increase in value. These values ranged from about $274 to almost $3,000, again depending on the species harvested, the bag limits, and in which region the trip occurred. Also, increases in bag limits, all else equal, had little discernible effect on total values, except possibly the case of increasing the bag limit from one to two fish in the Pacific halibut fishery.

Knowledge of the economic values of fisheries to anglers can be informative and useful in policy discussions. However, they are of course but one of numerous considerations that fishery managers must take into account when decisions are made.

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An Economic Profile of the Charter Fishing Fleet in California

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Charter Fishing in California

During 2012, anglers in California took over 544,000 saltwater fishing trips aboard charter or party boats, also known as commercial passenger fishing vessels (CPFV), and spent $120 million on charter trip-related expenditures in the state (NMFS, 2014). Charter anglers in California can choose from a large selection of different trips. In Southern California, anglers can take half-day or full-day trips targeting species such as yellowfin tuna, *Thunnus albacares*; albacore tuna, *Thunnus alalunga*; dolphinfish, *Coryphaena hippurus*; and yellowtail, *Seriola lalandi dorsalis*. Or they may choose overnight or longer trips further off the coast targeting Pacific bluefin tuna, *Thunnus orientalis*.

In the San Francisco area and north to the Oregon border, charter vessels take anglers out for Chinook salmon, *Oncorhynchus tshawytscha*. Throughout the state, anglers also target lingcod, *Ophiodon elongates*; vermillion rockfish, *Sebastes miniatus*; bocaccio, *S. paucispinis*; copper rockfish, *S. caurinus*; and yellowtail rockfish, *S. flavidus*. To better understand the economic sustainability of the industry and the financial situation for charter operators and crew, a survey focused on the 2012 season was administered in 2013 by the National Marine Fisheries Service's (NMFS) Southwest Fisheries Science Center (SWFSC) in La Jolla, Calif.

The survey is part of a series of national studies conducted regionally by NMFS on the recreational for-hire industry (e.g., charter and party boats) about every 5 years on a rotating basis. The Magnuson-Stevens Act, Executive Order 12866, and other federal regulations require NMFS to conduct economic analysis of the impacts of its management actions. The data collected in these surveys are used in the estimation of the economic contributions of the for-hire fleet to the local and regional economies and can be used to estimate the economic impacts of changes in the fishery.

These changes may include fishing regulations, such the establishment of marine protected areas which decrease available fishing grounds, and exogenous shocks to the industry such as rising costs associated with fishing and the effects of environmental changes on fishery stocks. The last survey of the CPFV fleet in California was conducted in 2000.[1] Given significant changes in the economy and California fisheries in the intervening years, an updated survey was needed to understand current economic conditions in the industry and the issues affecting it throughout the state.

Survey Methodology and Data Collection

The 2013 California survey was designed to collect information on 2012 cost and earnings data for each fishing business and closely followed the format and methods from recent for-hire surveys conducted or supported by NMFS in the northeast (Steinback and Brinson[2]), southeast (Liese and Carter,

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[1]West Coast Charter Boat Survey Summary Report, 2000. 2004. Unpublished report, Pac. States Mar. Fish. Comm., Econ. Data Prog., Spokane, Wash. (online at http://www.psmfc.org/efin).

[2]Steinback, S., and A. Brinson. 2013. The economics of the recreational for-hire fishing industry in the northeast United States. U.S. Dep. Commer., NOAA, Natl. Mar. Fish. Serv., North-

ABSTRACT—Charter fishing off the California coast has long been a popular recreational activity for both California residents and tourists alike. With its long coastline, mild climate, and productive offshore waters, anglers have a myriad of year-round opportunities to catch a wide variety of species. To better understand the economic structure and performance of the industry, the NMFS Southwest Fisheries Science Center conducted a survey on key economic performance measures related to profitability, productivity, demographics, and challenges facing the industry for the 2012 season. The survey was administered in 2013. This paper provides an updated economic profile of the charter industry in California that can be used in analyses of future fisheries policy actions. It also presents the results for both small and large vessels, with large vessels defined as 15.24 m (50 ft) or longer. Survey findings include that revenues net of cost average $42,033 per vessel in California, and that over 70% of owners are primary captains of at least one vessel. When asked about the factors affecting their business and industry, 71% of owners responded that fishery regulations were very challenging, while 36% responded that environmental conditions were very challenging.

Table 1.—Surveys administered and completed by vessel size and location.

Category	Total no. of active charter businesses	Surveys administered	Completed surveys	% complete of total businesses	% complete of administered
North large	19	18	17	89%	94%
North small	77	18	16	21%	89%
South large	108	65	55	51%	85%
South small	60	22	15	25%	68%
Total vessels	264	123	103	39%	84%

2011; Savolainen et al., 2011; Holland et al.[3]), Pacific Northwest (Leonard, 2016), and Pacific islands (Hospital and Beavers[4]). Hutt and Silva (2015) conducted a similar survey focused on for-hire vessels targeting Atlantic highly migratory species.

Many of these surveys have demonstrated that in-person interviews result in more accurate data. With that in mind, the survey sampling in California was divided into two phases consisting of in-person interviews in Phase 1, and a multi-mode design for Phase 2 with in-person, telephone, and mail-in options. This two-phase approach was thought to both maximize response rates and data quality. Although in-person interviews often result in better data, response rates may be lower due to scheduling difficulties. A mixed-mode design offers more scheduling flexibility and therefore a potentially higher response rate.

The survey was pre-tested using a pilot study of a small number of CPFV owner/operators in San Diego county, focused on the 2011 season, and was administered in 2012 (Hanan and Hanan[5]). Based on the pilot study, the 2012 survey questionnaire was organized into sections on industry participation, annual business based expenditures, vessel characteristics, annual vessel based expenditures, annual vessel based fishing operations revenue, annual vessel based non-fishing operations revenue, individual trip type expenses and revenues, owner opinion, and business structure and outlook.

The California Department of Fish and Wildlife (CDFW) provided NMFS with a list of all charter vessels registered in the state during 2012 and contact information for the owner. There were 339 registered vessels reported in the 2012 CPFV fishing logs. Of these, 324 vessels reported carrying at least one passenger on a sportfishing trip. Removal of vessels with no available contact information reduced the number of active vessels to 264 (Table 1). These 264 vessels were stratified into four groups based on a combination of geographic area (North and South) and vessel size.

The South area included San Diego, Orange, Los Angeles, Ventura, and Santa Barbara counties. The North area included all other coastal counties north of Santa Barbara. To explore the heterogeneity across vessel size classes, vessels 50 ft (15.24 m) or larger were classified as "Large" and vessels less than 50 ft as "Small." The CPFV fleet was then divided into four groups: North Large, South Large, North Small, and South Small. We limit this report to differences between large and small vessel categories. Future reports will provide details on the North/South subcategories.

The target population of the survey was charter businesses, rather than individual vessels. Each business may own one or more vessels. In Phase 1, 148 owners of a charter business were selected for in-person interviews from the list using stratified random sampling across the four location/size categories. In Phase 2, the remaining 116 owners were selected for either in-person interviews, phone interviews, or a mail survey (Hanan et al.[6]).

Table 1 shows the total number of charter businesses, the number of surveys administered, and completion rates for both phases. Inaccurate contact information, refusals, and inability to reach an owner after multiple attempts reduced the number of owners scheduled for the survey, both for the total fleet and stratified by vessel location and vessel size category. The total number of surveys administered in person, over the phone, or by mail was 123. Surveys with at least 95% of the questions answered were considered complete. Of those business owners who responded to the survey, 84% resulted in what was considered a completed survey. Of all the owners with active CPFV operations during 2012, 39% participated and completed the survey. Stratified by size of vessel, response rates were higher for large vessel businesses (57%) than small vessel businesses (23%). Survey summary statistics were estimated in STATA/MP (version 14.1, 2015)[7] using the subset of observations that were complete for each question.

CPFV Fleet Profile

The first panel of Table 2 provides the characteristics of CPFV owners as to their involvement in the fishery. Across all vessels, owners had an average of 33 years of experience with the industry in some capacity (e.g., deck hand, captain, cook). Owners of small vessels had on average 22 years of experience, compared to 39 years of experience for large vessel owners. Seventy-two percent of owners reported that they were also the primary captains of a CPFV. For owners of small vessels, 90% were also cap-

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[7]Mention of trade names or commercial firms does not imply endorsement by the National Marine Fisheries Service, NOAA.

Table 2.—Characteristics of owners and vessels by size of vessel.

Variable	Small			Large			Diff[1]	Total		
	N	Mean	Std. dev.	*N*	Mean	Std. dev.		*N*	Mean	Std. dev.
Owner demographics										
Years' experience in CPFV industry	31	22.1	16.6	72	38.7	12.0	***	103	33.7	15.5
% primary captain on any vessel	31	90.3%	30.1%	72	63.9%	48.4%	***	103	71.8%	45.2%
No. of vessels owned	31	1.4	0.9	72	2.3	1.8	***	103	2.0	1.6
% of income from CPFV operations	26	23.1%	18.7%	47	49.0%	29.2%	***	73	39.9%	28.7%
Vessel characteristics										
Gross tonnage	30	14.2	11.7	72	58.0	25.5	***	102	45.1	29.9
Length (ft)	31	33.7	8.4	72	65.0	13.2	***	103	55.5	18.7
Year built	31	1987	14.5	72	1973	13.4	***	103	1977	14.9
Maximum crew	30	1.9	0.9	72	3.6	3.6	***	102	3.1	3.1
Maximum no. of passengers	31	11.3	11.2	72	60.8	35.1	***	103	45.9	37.6
Maximum overnight passengers	11	5.7	3.8	36	30.5	14.7	***	47	24.7	16.7

[1]Significance of difference between mean of small and large vessel: $^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$.

Table 3.—Average revenues by vessel size.[1]

Variable	Small			Large			Diff[1]	Total		
	N	Mean	Std. dev.	*N*	Mean	Std. dev.		*N*	Mean	Std. dev.
Ticket sales and related fees	31	$77,271	$118,520	72	$343,120	$320,629	***	103	$263,107	$301,173
Food and beverage sales	31	$226	$1,257	72	$9,863	$23,994	**	103	$6,962	$20,517
Filet charges to vessel	31	$97	$539	71	$371	$2,257		102	$287	$1,906
Souvenirs	31	$79	$366	70	$127	$419		101	$112	$402
CDFW angler license commissions	31	$261	$1,455	71	$0	$0		102	$79	$802
Average subtotal: Recreational fishing	31	$77,934	$118,567	72	$353,472	$326,805	***	103	$270,543	$307,582
Nonfishing recreation	31	$3,117	$12,690	70	$79,030	$156,384	***	101	$55,730	$134,763
Commercial fishing	31	$14,880	$59,339	70	$3,645	$20,175		101	$7,093	$36,936
Nonrecreational charter	31	$232	$533	68	$7,809	$26,451		99	$5,437	$22,156
Lodging	31	$0	$0	70	$0	$0		101	$0	$0
Equipment rental	31	$0	$0	70	$0	$0		101	$0	$0
Average subtotal: Nonrecreational fishing	31	$18,230	$59,951	72	$87,753	$159,574	**	103	$66,829	$140,744
Average total revenues	31	$96,163	$132,519	72	$441,225	$369,858	***	103	$337,371	$354,515

[1]Average subtotal and total calculations are the average of individual vessel totals summed over all categories and may not equal the sum of the average per category. This is due to the exclusion of missing values in the calculation of category averages, and the implicit impact of the missing values being treated as zeros in the calculation of individual vessel totals.
[2]Significance of difference between mean of small and large vessel: $^{*}p < 0.1$, $^{*}p < 0.05$, $^{***}p < 0.01$.

tains. The percentage was much lower for large vessel owners, where 64% reported that they were also captains. The average number of vessels owned by a single owner was two (2.0) for all respondents with slightly lower averages for small vessel owners (1.4) compared to large vessel owners (2.3).

Across all vessels, owners received 40% of their income from CPFV operations on average. Owners of small vessels received 23% of their income from CPFV operations, whereas owners of large vessels received 49%. Table 2 also provides the results of t-tests on the differences in the means between large and small vessels for each of the owner characteristics. The results indicate statistically significant differences in all of the characteristics.

The second panel of Table 2 reports summary statistics for vessel characteristics. The average CPFV has a gross tonnage of 45 (40.8 t), a length of 56 feet (16.9 m), and was built in 1977. Small vessels average a gross tonnage of 14 (12.7 t) and a length of 34 feet (10.4 m). Large vessels averaged 58 tons (52.6 t) and 65 feet (19.8 m). Small vessels are newer by 14 years on average, having been built in 1987, compared to large vessels that were built in 1973.

The maximum number of crew was 3 for all vessels and the maximum number of passengers was 46. Smaller vessels have an average crew size of 2 and hold a maximum of 11 passengers. Larger vessels have a crew size of 4 on average and hold a maximum of 61 passengers. Overnight trips are offered by a subset of 47 out of 103 vessels from both size classes. On average these vessels have an overnight capacity of 25 passengers. Eleven (11) out of 31 of the small vessels offer overnight trips with an average overnight capacity of 6 passengers. Thirty-six (36) of the 72 large vessels offer overnight trips with an average overnight capacity of 31 passengers. All vessel characteristics showed statistically significant differences between the means of large and small vessels.

Costs and Earnings

Table 3 reports the average revenues for vessels in the CPFV fleet. Average revenues were calculated at the CPFV level, rather than owner level. The average total revenues across all categories were $337,371 for all vessels, $96,163 for small vessels, and $441,225 for large vessels.[8] Table 3 also shows revenues stratified by

[8]Average total calculations are the average of individual vessel totals summed over all categories and may not equal the sum of the average per category. This is due to the exclusion of missing values in the calculation of category averages, and the implicit impact of the missing values being treated as zeros in the calculation of individual vessel totals.

Table 4.—Average expenditures and net revenue by vessel size.[1]

Variable	Small			Large			Total		
	N	Mean	Std. dev.	*N*	Mean	Std. dev.	Diff[2]	*N*	Mean	Std. dev.
Payroll for skipper and crew	31	$10,677	$11,383	70	$94,939	$82,432	***	101	$69,076	$79,076
Vessel fuel costs	31	$17,520	$37,540	68	$86,790	$106,489	***	99	$65,100	$96,056
Bait costs	30	$3,910	$5,987	72	$34,047	$27,745	***	102	$25,183	$27,237
Booking fees	31	$6,292	$13,463	72	$27,915	$27,175	***	103	$21,407	$25,821
Equipment purchases, repair and maintenance	31	$8,369	$13,442	72	$25,487	$22,650	***	103	$20,335	$21,737
Food and drink costs	31	$427	$1,282	67	$21,972	$44,701	***	98	$15,157	$38,230
Moorage	31	$4,613	$4,076	71	$13,241	$16,487	***	102	$10,619	$14,465
Foreign taxes, gov't. fees, and fishing licenses	31	$185	$604	71	$7,207	$18,388	**	102	$5,073	$15,652
Annual principal payment on vessels	30	$299	$932	68	$6,542	$15,194	**	98	$4,631	$12,965
U.S. taxes, gov't. fees, and vessel permits	30	$3,406	$4,778	72	$4,969	$9,268		102	$4,509	$8,213
Haul out costs	29	$648	$1,397	68	$5,697	$7,823	***	97	$4,188	$6,978
Annual interest payment on vessels	30	$128	$479	67	$3,251	$8,439	**	97	$2,285	$7,151
Industry association fees/memberships	30	$334	$577	71	$2,692	$3,113	***	101	$1,992	$2,838
Ice (purchased dockside)	31	$262	$562	71	$348	$799		102	$322	$733
Average subtotal: Vessel expenditures	31	$56,768	$56,291	72	$324,880	$293,795	***	103	$244,186	$276,200
Payroll of nonvessel personnel	31	$1,048	$3,535	71	$17,527	$27,378	***	102	$12,519	$24,109
Insurance	31	$4,872	$6,100	72	$14,380	$7,167	***	103	$11,518	$8,118
Rent paid on office space used for business	30	$2,668	$4,610	69	$13,187	$27,100	**	99	$10,000	$23,227
Advertising services or charges	31	$2,808	$4,059	71	$9,584	$12,688	***	102	$7,525	$11,238
Professional services (legal, accounting, etc.)	31	$1,102	$2,276	72	$6,016	$7,611	***	103	$4,537	$6,854
Telephone and other communications	31	$2,320	$4,289	71	$4,001	$4,628	*	102	$3,490	$4,573
Lease or loan payments for business motor vehicles	31	$368	$881	71	$3,003	$10,472		102	$2,202	$8,816
Average subtotal: Business expenditures	31	$15,099	$16,046	72	$66,675	$67,346	***	103	$51,152	$61,626
Average total expenditures	31	$71,866	$62,986	72	$391,555	$330,477	***	103	$295,338	$314,486
Average vessel net revenue	31	$24,297	$134,123	72	$49,670	$200,463		103	$42,033	$182,757

[1]Average subtotal and total calculations are the average of individual vessel totals summed over all categories and may not equal the sum of the average per category. This is due to the exclusion of missing values in the calculation of category averages, and the implicit impact of the missing values being treated as zeros in the calculation of individual vessel totals.
[2]Significance of difference between mean of small and large vessel: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

recreational fishing based revenues and nonrecreational fishing based revenues.

Across all vessels, total recreational fishing based revenues average $270,543 and total nonrecreational fishing based revenues average $66,829. For small vessels, the average of total revenues across recreational fishing and nonrecreational fishing revenue categories are $77,934 and $18,230. For large vessels, the average of total revenues across recreational fishing and nonrecreational fishing revenues are $353,472 and $87,753. The following paragraph provides a breakout of revenues by category.

Ticket sales and related fees, such as fuel surcharges, rod rentals, gunny sack, and bunk surcharges, were the largest revenue category for all vessels regardless of size of the CPFV. On average, a vessel collected $263,107 in ticket sales and related fees, with small vessels collecting $77,271, and large vessels collecting $343,120. Across all vessels, nonfishing recreational charters, commercial fishing activities, and food and beverage sales were the 2nd, 3rd, and 4th largest revenue streams with revenues of $55,730, $7,093, and $6,962, respectively.

Based on size of the vessel, there is a difference in the next highest revenue-generating activity. Smaller vessels generate $14,880 in commercial fishing related revenues, followed by $3,117 in nonfishing recreational trips. While for large vessels, nonfishing recreational trips account for $79,030 in average revenues, followed by food and beverage sales of $9,863. Small vessels report $226 in food and beverage sales, and large vessels report $3,645 in commercial fishing activities.

Nonrecreational and nonfishing charter trips account for $5,437 of revenues across all vessels; with an average of $232 in revenues for small vessels, and $7,809 in revenues for large vessels. Other revenue sources include filet charges, sales of souvenirs, and commissions on angler licenses. These categories accounted for an average of $287, $112, and $79 in revenues, respectively across all vessels. For small vessels the average revenues were $97, $79, and $261, respectively, while for large vessels average revenues were $371, $127, and $0, respectively. None of the CPFV's reported revenues from lodging or equipment rentals.

Expenditures are reported in Table 4 after allocating expenditures to the vessel level. In cases where business expenses were split between multiple vessels, an even share of the expenses were attributed to each vessel. Table 4 reports expenditures by individual expenditure category; individual categories are organized into both vessel expenditures (top panel) and business expenditures (bottom panel). Total average expenditures were $295,338 for all vessels, $391,555 for large vessels, and $71,866 for small vessels.

Expenditures on payroll for the skipper/captain and the crew was the largest expenditure category on average for all vessels and for large vessels. For all vessels, payroll was $69,076 on average; for large vessels it was $94,939. For small vessels, average payroll expenditures were $10,677. The second largest category of expenditures for all vessels was for fuel costs, averaging

Table 5.—Average vessel and trip characteristics by trip length and vessel size.[1]

	Small			Large				Total		
Variable	N	Mean	Std. dev.	N	Mean	Std. dev.	Diff[2]	N	Mean	Std. dev.
Annual angler days–partial day	14	260	277	28	5,369	6,133	***	42	3,666	5,544
Annual angler days–full day	23	572	801	43	2,800	2,195	***	66	2,024	2,115
Annual angler days–overnight	3	–	–	22	1,254	1,518	–	25	–	–
Annual angler days–long distance	0	n/a	n/a	16	3,197	2,350	n/a	16	3,197	2,350
% of angler days–partial day	14	69%	36%	28	57%	32%		42	61%	33%
% of angler days–full day	23	76%	35%	43	67%	34%		66	70%	35%
% of angler days–overnight	3	–	–	22	52%	44%	–	25	–	–
% of angler days–long distance	0	n/a	n/a	16	79%	30%	n/a	16	79%	30%
Length of trip in hours–partial day	14	4.9	1.0	28	6.0	1.5	**	42	5.6	1.4
Length of trip in hours–full day	23	8.8	1.5	43	10.3	1.8	***	66	9.8	1.8
Length of trip in hours–overnight[3]	3	–	–	22	24.0	6.5	–	25	–	–
Length of trip in hour–long distance	0	n/a	n/a	16	102	54	n/a	16	102	54

[1]Average statistics are conditional on the vessel providing the respective trip length. Zero values are excluded from calculations.
[2]Significance of difference between mean of small and large vessel: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.
[3]Averages not shown to maintain confidentiality when three or fewer responses are provided.

$65,100 per vessel. For small vessels, fuel costs, at $17,520, were higher than payroll costs and the largest expenditure category. For large vessels fuel costs were the second highest expense at $86,790. For small vessels, however, fuel costs were the highest average expenditure ($17,520).

Bait expenditures were the third highest expenditure category across all vessels and for large vessels, with an average of $25,183 and $34,047, respectively. Small vessels report average bait expenditures of $3,910. On smaller vessels, the third highest type of expenditure was equipment purchases, repair, and maintenance averaging $8,369. For all vessels, the average total for vessel expenditures was $244,186. For small vessels, the average total for vessel expenditures was $56,768; large vessels averaged $324,880.

In terms of business expenditures, the highest expenditure for all vessels and for large vessels was payroll of nonvessel personnel; $12,519 and $17,527, respectively. Insurance was the second highest business expense. For all vessels, insurance expenditures averaged $11,518. For large vessels, average insurance expenditures were $14,380. For small vessels, insurance was the number one business expense, averaging $4,872. Rent paid on office space ($10,000) and advertising services ($7,525) were the third and fourth highest expenditures for all vessels. For all vessels, average business expenditures were $51,152. For large vessels, the average was $66,675, and for small vessels, the average was $15,099.

The average net vessel revenue across all vessels was $42,033. Small vessels had average net revenues of $24,297. On average, net revenues for large vessels were $49,670. Positive average net revenues across the fleet and for both vessel size stratifications indicate that, on average, the fleet is profitable. However, the large standard deviation statistics across fleet-wide, small vessel, and large vessel net revenue statistics indicate that many individual boats have negative net-revenues.

Average Trip Characteristics

The survey asked owners a series of questions regarding the characteristics of an average trip for different trip lengths that are common in the CPFV fleet. The trip length categories are partial-day (half-day and twilight trips), full-day (includes 3/4 day trips), overnight (includes day and a half trips), and long-distance (includes multi-day trips, and trips to Mexico and international waters). Stratified by trip length and size of vessel, Table 5 shows the average per vessel annual number of angler days, the average vessel percentage of angler days, and the average length of a trip in hours; all three statistics are conditional on the vessel providing the respective trip length. Results are broken out by vessel size categories (small, large, and all vessels). An angler day is measured as either a partial or full-day trip by one angler.

The first four rows of Table 5 report the average vessel annual number of angler days provided by trip length and the corresponding standard deviation; all statistics are conditional on the vessel having offered trips of the respective size class. For partial day trips, the average per vessel annual number of angler days was 3,666 for all vessels. Small vessels averaged 260 angler days and large vessels averaged 5,369 angler days on partial-day trips; the difference between small and large is statistically different at the 1% level.

On full-day trips, the average per vessel annual number of angler days was 2,024 angler days for all vessels. Small vessels averaged 572 angler days, and large vessels averaged 2,800 angler days on full-day trips; the difference between small and large is statistically different at the 1% level. For overnight trips, the average per vessel annual number of angler days was 1,245 for large vessels. Statistics for small and all vessels are not provided due to confidentially concerns. For long distance trips, the average per vessel annual number of angler days was 3,197 for large vessels; no long distance trips were reported by small vessels.

The second four rows of Table 5 report the average vessel percentage of angler days provided by trip length and the corresponding standard devia-

tion; all statistics are conditional on the vessel having offered a trip of the respective size class. For partial day trips, the average per vessel percentage of angler days was 61% for all vessels. Small vessels averaged 69% and large vessels averaged 57%; the difference between small and large vessels is not considered to be statistically different at any conventional level. On full-day trips, the average per vessel percentage of angler days was 70% for all vessels. Small vessels averaged 76% and large vessels averaged 67% for full day trips; the difference between small and large vessels is not considered to be statistically different at any conventional level. On overnight trips, the average per vessel percentage of angler days was 52% for large vessels. Statistics for small and all vessels are not provided due to confidentially concerns. For long distance trips, the average per vessel percentage of angler days was 79% for large vessels; no long distance trips were reported by small vessels.

The third four rows of Table 5 report the average vessel length of a trip in hours (h) by trip length and the corresponding standard deviation; all statistics are conditional on the vessel having offered a trip of the respective size class. For partial day trips, the average per vessel length of a trip was 5.6 h for all vessels. Small vessel trips averaged 4.9 h, and large vessels averaged 6 h on partial-day trips; the difference between small and large is statistically different at the 5% level. On full-day trips, the average per vessel length of a trip was 9.8 h for all vessels. Small vessel trips averaged 8.8 h, and large vessels averaged 10.3 h for full day trips; the difference between small and large is statistically different at the 1% level. For overnight trips, the average per vessel length of trip was 24 h, or 1 day, for large vessels. Statistics for small and all vessels are not provided due to confidentially concerns. For long distance trips, the average per vessel length of trip was 102 h, or over 4 days, for large vessels; no long distance trips were reported by small vessels.

Table 6.—Factors affecting CPFV businesses and the industry.

Item	Percentage of owners answering					
	Very challenging	Somewhat challenging	Neutral	Somewhat favorable	Very favorable	*N*
Small vessel						
Fishery regulations (including MPA's)	65%	13%	13%	3%	6%	31
Non-fishery gov't. regulations	26%	35%	35%	3%	0%	31
Environmental conditions	35%	39%	23%	3%	0%	31
Ocean and fish stock health	39%	23%	10%	19%	10%	31
Large vessel						
Fishery regulations (including MPA's)	73%	17%	6%	4%	0%	71
Non-fishery gov't. regulations	39%	42%	15%	4%	0%	72
Environmental conditions	37%	28%	34%	1%	0%	71
Ocean and fish stock health	21%	29%	18%	12%	21%	68
Total						
Fishery regulations (including MPA's)	71%	16%	8%	4%	2%	102
Non-fishery gov't. regulations	35%	40%	21%	4%	0%	103
Environmental conditions	36%	31%	30%	2%	0%	102
Ocean and fish stock health	26%	27%	15%	14%	17%	99

Table 5 provides empirical support of the following insights. First, full day trips are the most commonly offered, regardless of vessel size class. Overall, 66 out of 103 vessels which completed the survey offered full day trips; corresponding figures for small and large vessels are 23 out of 33, and 43 out of 72, respectively. Partial day trips were the second most commonly offered, regardless of vessel size. For vessels that offered full-day trips, these trips made up the majority of their annual passenger loads. Over all vessels, full-day trips made up an average of 70% of vessel days for vessels that provided them; corresponding figures for small and large vessels are 76% and 67%, respectively.

A second insight is that most vessels specialize in one primary trip length and then fill in their schedules with secondary trip length. Evidence of this can be seen in the high average and standard deviation percentages by trip length, and the spread of the number of vessels offering each trip length. A third insight is that there is consistency in the length of trips in hours as reported by vessels for each trip length category.

Factors Affecting Business Operations

To understand the factors impacting individual CPFV businesses and the industry overall, a series of short questions were asked about regulations, the environment, and a few broader economic issues. Respondents were asked to rate each issue as very challenging, somewhat challenging, neutral, somewhat favorable, or very favorable. For brevity, the issues that at least 50% of owners rated as very challenging or somewhat challenging are presented in Table 6.[9]

One of the issues that a majority of respondents rated as very challenging was "fishery regulations including marine protected areas (MPA's)." Overall, 71% of owners rated it as very challenging. For owners of large vessels, 73% rated it as very challenging and 17% as somewhat challenging. For small vessel owners, 65% rated it as very challenging and 13% as somewhat challenging. Non-fishery government regulations were rated by only 35% of owners as very challenging, and by 40% as somewhat challenging; during the interviews some vessel owners noted that safety regulations were appreciated. Thirty-nine percent of large vessel owners replied that these regulations were very challenging compared to 26% of small vessel owners.

Environmental conditions were rated as very challenging by 36% of all vessel owners, 37% of large vessel owners, and 35% of small vessel owners.

[9]The results of other issues are available upon request from the NMFS Southwest Fish. Sci. Cent.

Ocean and fish stock health concerned fewer of the large vessel owners, with 21% rating it as very challenging and 29% as somewhat challenging. For small vessel owners, the issue was a larger concern, with 39% rating it as very challenging, compared to 23% who rated it as somewhat challenging.

Discussion

This paper presents results of a survey of CPFV businesses that asked questions about the 2012 fishing season. Updated information on the financial situation facing individual vessel owners and the industry overall is critical to understanding how current and future environmental conditions, economic trends, and fisheries regulations will impact the future sustainability of this important sector of the California economy. Response rates to the survey were comparable to other similar surveys around the country; the 2010 survey in the Northeast had an overall response rate of 48% (Steinback and Brinson[2]); a 2012 survey in the Pacific Northwest had a 55% response rate (Leonard[10]). For large California charter vessels, the response rate in this survey was 57%, however, the percentage was lower for the small vessels (23%). The high level of outreach prior to the start of the survey appears to have positively affected willingness to participate.

Prior to the actual survey, SWFSC economists and the contractor met with many angling groups to discuss the upcoming survey, worked with angling associations to publicize it, and conducted a pilot study to get feedback on the questionnaire. Additionally, the use of in-person interviews resulted in a higher number of complete interviews than the other methods, with an 87% completion rate. Over-the-phone interviews had an 86% completion rate. In contrast, the mail-based surveys in Phase 2 had a completion rate of 38%. Another factor that appeared to increase willingness to participate was having interviews conducted prior to the start of the fishing season, when owners had more time available. Interviews conducted in the off season resulted in higher completion rates than those conducted once the busy fishing season was underway.

In 2012, average characteristics of both owners and vessels illustrate that the owners are highly experienced with over 30 years in the industry. Owners of small vessels are very engaged in daily operations as 90% captain their own vessel. For large vessel owners, 64% are captains of their own vessel. In contrast, the study conducted in 2000 found that a larger share of owners of large vessels in Northern California operated their own vessels (100%) and a smaller share of owners of large vessels in Southern California operated their vessels (42%).[11] For small/medium vessels, between 84% and 100% were operated in 2000 by the owner in both areas of the state, which is not too different from the 90% average in 2012 for boats under 50 ft. The 2012 results show that small-vessel owners own one boat on average, and large-vessel owners own about two boats on average. In 2000, primarily only owners of large vessels in Southern California owned more than one vessel (58%).

In 2000, the average crew size for large vessels varied between 1.2 full-time crew in Northern California, and 4.3 full-time crew in Southern California. By 2013, this average was 3.6 crew statewide for large vessels. For small and medium-sized vessels in 2000, the range was from 0.2 full-time crew (small, Southern California) to 8.9 (small, Northern California). In 2012, the small vessel category had 1.9 crew on average.

Owners of large vessels in 2012 obtain 80% of their revenues on average from recreational fishing trips (Table 3). For large vessels in Northern California this was an increase since 2000, when they earned 74% of their vessel-based revenues from recreational angling trips, but a decrease for large vessels in Southern California where the percentage was 87%.

Ticket sales in 2012 for recreational fishing account for the largest share of revenues regardless of vessel size. However, there is a difference in large vs. small vessels in terms of what other sources of revenue are important to their operations. Small vessels are more likely to have an additional income stream related to commercial fishing relative to large vessels, and large vessels have a significant source of revenue from non-fishing related recreational trips. Overall, this diversity in revenue streams probably helps owners and crew in terms of financial stability over the year and may help them to compensate for seasonal downturns in recreational fishing activity. Overall, CPFV vessels in 2012 had average net revenues of $42,000.

The largest average expenditure categories in 2012 were payroll for crew ($69,000) and fuel costs ($65,000) for all vessel size categories. In 2000, similar patterns were observed across most of the state for both large, medium, and small vessels. In a few cases, fuel costs were slightly higher than payroll costs, but together these two categories made up a large share of overall expenditures.

An issue causing concern among CPFV owners in 2012 was government fisheries regulations. Over 70% responded to this question stating that this was a very challenging issue for their business. The survey did not go into specifics about which type of regulations were more difficult, other than to include marine protected areas as an example of regulations. Given the recent establishment of marine protected areas off the California coast, this issue may have been forefront in the minds of owners. Prior to the finalization of the regulations governing marine protected areas, there was a lot of uncertainty among anglers and the public over what areas were actu-

[10]Leonard, Jerry. NMFS Northwest Fish. Sci. Cent., Seattle, Wash. Personal commun. 22 Feb. 2016.

[11]In the cost and earnings survey conducted in 2000, the strata included Northern and Southern California, and vessels were classified as small, medium, or large. Large vessels were defined as 50 ft or larger (15.24 m), similar to the current study's definition of large vessels. However, results were not aggregated across strata, so it is not possible to make a one-to-one comparison to the same categories as in the current study.

ally open to recreational fishing and what restrictions might be on the horizon. This uncertainty may have been the reason that fisheries regulations were listed as a top concern among the CPFV owners and operators. More research is needed to investigate specifically how the establishment of MPA's will affect the CPFV industry in future years.

The study was designed to provide a concise, descriptive overview of the survey results. Future analysis on the survey results will look into more comparative results, such as the differences in vessels located in Northern California vs. Southern California to see whether or not the differences in fisheries across the state geographically translate into differences in the financial profile of the industry. The survey results can also be used to estimate the economic contributions of the industry to the economy of California in terms of jobs supported and contributions to the state's gross domestic product. Finally, future research should use the results of this study in California to investigate the differences or similarities facing the for-hire industry in the different regions of the country, using the other for-hire surveys recently conducted by NMFS or its partners.

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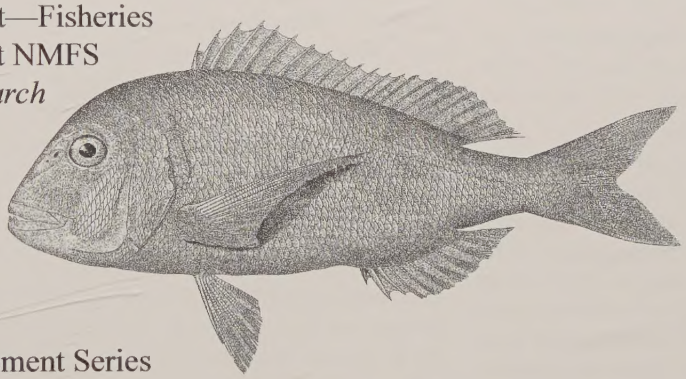

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